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THE INDIANS OF PANAMA

THEIR PHYSICAL RELATION TO THE MAYAS

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In the early months of 1924 Mr. John L. Baer, Assistant in my Division for a time, visited the Indians from the Gulf of Darien, Panama, inland,[1] for purposes of anthropological observations. Due to an infection Mr. Baer in a short time perished in that country; but before he came to his end he secured a series of measurements on two tribes of the Indian inhabitants. These were the first anthropometric data of consequence on these people, and they were fortunately saved.[2] They will be of value in connection with the studies on the San Blas albinos, but

[1]For further details see this Journal, No. 2, 1925, 201.

[2]Mr. Baer received training in measuring from me, and carried the standard instruments (see author's "Anthropometry," 8°, 1920, Wistar Inst., Phila., p. 56).

A few notes from Mr. Baer's diary on his work with the Indians follow. The photos came without identification.

"*Indians: Camp Townsend: Saturday, Feb. 9:* Put up charts for taking span and height measurements.

Sunday, Feb. 10: Jose Mata and family gave us a call. Took picture of him and squaw. Jose made her put on new dress for the occasion and naked son would not appear.

Tuesday, Feb. 12: Group of Chocos arrived. Snapped man and 10 year daughter.

Wednesday, Feb. 13: Awakened by chatter of Chocos in Marsh's tent. Morning spent photographing and studying group of dozen children.

Thursday, Feb. 14: Measured a number of Cunas and a few Chocos. Photographed Jose and family, also courting Chocos.

Friday, Feb. 15: Measured Mayo Benito and wife and other Chocos. Photographed old man and group from Topisa. Face painted with red daubs.

Monday, March 3: Measured two Chocos from whom I bought leopard skin. Photographed men with skin. Copied measurements. Measured man and woman. Photographed group of Chocos.

Tuesday, March 11: Packed outfit for trip to see other Cunas on Rio Paiju.

Friday, March 14: Took picture of woman and child.

Saturday, March 15: Measured several Indians and took a couple of pictures.

Sunday, March 16: Measured more Indians and saw some good material. Tried to see albino, who ran into the jungle.

Monday, March 17: Measured Cuna women from 9–12. Saw albino and sister weaving hammock.

Monday, March 24: Measured two Cunas from Eio Capeti. Chief Bibio gave us some good information about Cunas farther up river.

Tuesday, March 25: Worked on data to show comparison between Cunas and Choose.

as will be shown they prove also to be of very considerable interest as to racial connections. A brief report on the data will be given in this paper.

The two tribes, in a loose way neighbors, were the Cunas and the Chocos. The Cunas, who call themselves also "Cuna-Caribe," live along the coast, the Chocos are inland. Of the former, Mr. Baer measured 27 men and 20 women, of the latter 10 men and 9 women. No apparently immature or again senile individuals were included. The ages of the men ranged from approximately 20 to 60, of the women from 18 to 45.

Much to our surprise the two tribes are shown to belong to two separate types of the Indian. But even more interesting and important are the facts that the type of the inland people, the Chocos, nears that of the Nahua, while that of the coastal Cunas is evidently very close on one hand to that of the Mayas of Yucatan, and on the other to that of the Yungas who extended for a great distance along the western coast of South America, to below Nasca. The characteristics and differences between the two will be seen from the following:

The Cunas: are on the average, of small stature	*The Chocos:* slightly taller.
very brachycephalic	meso- to moderately brachycephalic
the head is low	the head is high
the arms and legs are rather long	arms and legs shorter
the head absolutely and relatively slightly larger	head slightly smaller
face—similar in the two	
nose longer	nose shorter
nasal index lower	nasal index higher
mouth, chest and hands similar in the two	
foot slightly longer and narrower, index lower	foot slightly shorter and broader; index higher
temperature similar in the two	
pulse and respiration somewhat more frequent	both somewhat slower
ears markedly shorter, index higher	ears longer, trace narrower; index lower
muscular strength somewhat less	strength somewhat greater, especially in males

TABLE 1. ABSTRACTS OF MEASUREMENTS

	Age	Ht.	Max. finger-reach	Excess of finger-reach over Ht.	Sitting Ht.	Sitting Ht. % of total Ht.	Head: d. ant. post.	D. lateral max.	Cephalic index	Ht. line between aud-meati and bregma	Mean head Ht. index	Cephalic module	Cephalic module vs. stature	Face: menton-nasion	Menton-crinion	Ht. of forehead (nasion-crinion)	Diam. bizygom. max.	Facial index, phys.	Facial index, morph.	Diam. frontal min.	Diam. bigonial	Nose: Ht. to nasion.
Cuna♂	(20)	(20)	(20)	(20)	(20)		(20)	(20)		(20)				(20)	(20)	(20)	(20)			(20)	(20)	(20)
Averages	*32*	*154.9*	*164.4*	*+9.4*	*80.2*	*51.8*	*18.2*	*15.6*	*85.7*	*12.6*	*74.6*	*15.47*	*99.9*	*12.–*	*18.4*	*6.4*	*13.9*	*75.5*	*86.3*	*11.3*	*10.3*	*5.4*
Minima	21	146.–	153.–	+2.–	75.–	*49.5*	17.2	14.9	*80.1*	11.9	*72.2*	14.73	*94.8*	10.9	17.3	5.6	13.2	*66.5*	*79.3*	10.4	9.4	4.7
Maxima	60	161.5	175.–	+16.–	86.–	*54.3*	19.2	16.4	*89.2*	13.2	*78.6*	16.17	*108.–*	13.5	20.1	7.4	15.2	*81.7*	*95.7*	12.1	11.1	6.3
Cuna♀	(9)	(9)	(9)	(9)	(9)		(9)	(9)		(9)				(9)	(9)	(9)	(9)			(9)	(9)	(9)
Averages	*31*	*143.2*	*148.5*	*+ 5.3*	*75.4*	*52.6*	*17.5*	*15.2*	*86.9*	*12.2*	*74.4*	*14.97*	*104.5*	*10.8*	*16.8*	*5.9*	*13.5*	*79.9*	*80.–*	*10.7*	*10.3*	*5.1*
Minima	18	135.5	140.–	+ 3.–	70.5	*50.9*	16.9	14.–	*82.8*	11.6	*71.8*	14.17	*99.5*	10.–	15.9	4.9	12.7	*77.–*	*77.1*	10.–	9.8	4.5
Maxima	45	153.–	157.5	+10.–	78.5	*56.1*	18.–	16.1	*91.1*	12.5	*76.5*	15.45	*109.7*	11.8	17.4	6.5	14.–	*86.9*	*84.9*	11.2	11.8	5.9
Choco♂	(27)	(27)	(25)	(25)	(27)		(27)	(27)		(27)				(27)	(27)	(27)	(27)			(27)	(27)	(27)
Averages	*30*	*156.4*	*162.–*	*+ 5.7*	*83.8*	*53.6*	*18.3*	*14.7*	*80.3*	*13.5*	*81.8*	*15.50*	*99.1*	*11.7*	*18.1*	*6.4*	*13.7*	*75.7*	*85.4*	*11.–*	*10.2*	*5.1*
Minima	20	148.–	153.5	+ 2.–	80.–	*51.6*	17.3	13.6	*74.7*	12.8	*78.6*	14.83	*93.7*	10.8	16.2	5.1	12.8	*66.7*	*77.2*	10.3	9.4	4.6
Maxima	58	166.5	172.5	+11.5	90.5	*55.3*	19.2	15.8	*89.1*	14.2	*84.4*	16.23	*108.2*	12.8	20.1	7.5	14.6	*85.2*	*100.–*	11.8	10.8	6.–
Choco♀	(10)	(10)	(10)	(10)	(10)		(10)	(10)		(10)				(10)	(10)	(10)	(10)			(10)	(10)	(10)
Averages	*30*	*145.3*	*147.8*	*+ 2.4*	*80.–*	*55.1*	*17.6*	*14.2*	*80.7*	*13.3*	*83.6*	*15.03*	*103.4*	*10.8*	*16.7*	*5.9*	*13.2*	*79.–*	*81.8*	*10.7*	*10.1*	*4.6*
Minima	19	136.5	141.–	— 1.–	75.5	*54.1*	17.–	13.8	*76.4*	12.9	*80.9*	14.73	*99.2*	10.2	15.1	4.6	12.7	*72.5*	*76.7*	10.3	9.5	4.1
Maxima	40	151.–	153.5	+ 6.–	84.–	*56.8*	18.2	15.–	*84.3*	13.8	*87.8*	15.63	*109.4*	11.6	17.9	6.8	14.–	*88.7*	*89.9*	11.4	10.4	5.1

TABLE 1 (*Continued*)

	Nose, width max	Nasal index	Mouth, width	Chest, d. lateral	Chest, d. ant. post.	Chest index	Left hand, length	Left hand, width	Hand index	Left foot, length	Left foot, width	Foot index	Left leg circum. max.	Temp. (subling.)	Pulse	Respiration	Left ear, Ht.	Left ear, Br.	Left ear index	Pressure, right hand	Presure, left hand
Cuna ♂	(20)		(20)	(20)	(20)		(20)	(20)		(20)	(20)		(20)	(20)	(20)	(20)	(20)	(20)		(19)	(19)
Averages	*3.8*	*70.4*	*5.1*	*30.9*	*21.2*	*68.6*	*17.2*	*8.3*	*48.3*	*24.1*	*10.4*	*43.2*	*33.1*	*98.5*	*74.3*	*23.8*	*6.–*	*3.4*	*56.7*	*30.8*	*25.6*
Minima	3.5	*58.3*	4.6	28.7	19.9	*63.6*	16.2	7.6	*45.2*	22.2	9.7	*39.8*	30.2	97.7	65.–	18.–	5.3	3.–	*50.8*	20.–	18.–
Maxima	4.1	*81.2*	5.7	33.3	22.7	*73.–*	18.6	8.7	*51.8*	25.7	10.7	*46.3*	38.8	99.5	90.–	30.–	7.1	3.7	*67.9*	40.–	35.–
Cuna ♀	(9)		(9)	(9)	(9)		(9)	(9)		(9)	(9)			(9)	(9)	(9)	(9)	(9)		(9)	(9)
Averages	*3.5*	*68.6*	*4.9*	*29.2*	*22.3*	*76.4*	*15.8*	*7.4*	*46.8*	*22.1*	*9.7*	*43.9*	—	*99.–*	*81.2*	*27.9*	*5.8*	*3.3*	*56.9*	*19.7*	*15.5*
Minima	3.2	*62.7*	4.5	28.1	20.8	*73.6*	14.9	7.1	*44.8*	20.4	8.9	*41.2*	—	98.4	64.–	22.–	5.3	2.9	*52.5*	15.–	11.–
Maxima	3.8	*80.–*	5.2	30.9	23.7	*81.8*	16.5	7.8	*48.7*	23.1	10.2	*47.9*	—	99.5	87.–	34.–	6.1	3.6	*63.2*	24.–	24.–
Choco ♂	(27)		(27)	(27)	(27)		(27)	(27)		(27)	(27)		(27)	(27)	(27)	(27)	(27)	(27)		(27)	(27)
Averages	*3.8*	*74.5*	*5.2*	*30.9*	*20.8*	*67.3*	*17.–*	*8.3*	*48.8*	*23.6*	*10.6*	*44.9*	*34.4*	*98.7*	*69.6*	*22.6*	*6.5*	*3.3*	*50.8*	*33.7*	*29.5*
Minima	3.4	*62..5*	4.6	28.2	18.6	*63.8*	16.–	7.8	*46.1*	22.2	9.8	*42.–*	30.6	97.5	56.–	18.–	5.8	3.–	*42.1*	22.–	18.–
Maxima	4.2	*87.5*	5.7	33.6	24.3	*75.–*	19.–	9.5	*51.5*	25.4	11.3	*48.1*	39.–	99.9	91.–	27.–	7.6	3.9	*56.9*	42.–	39.–
Choco ♀	(10)		(10)	(10)	(10)		(10)	(10)		(10)	(10)			(5)	(5)	(5)	(5)	(5)		(5)	(5)
Averages	*3.5*	*76.1*	*4.9*	*28.7*	*22.1*	*77.–*	*16.–*	*7.6*	*47.5*	*21.9*	*9.9*	*45.2*	—	*98.8*	*71.6*	*23.6*	*6.3*	*2.9*	*46.–*	*18.4*	*14.8*
Minima	3.2	*70.6*	4.3	27.1	20.3	*74.1*	15.1	7.1	*45.5*	20.8	8.6	*41.3*	—	98.4	68.–	22.–	5.5	2.7	*41.7*	15.–	11.–
Maxima	3.7	*81.4*	5.4	31.1	23.6	*81.8*	16.6	7.9	*49.4*	24.1	11.1	*49.8*	—	99.1	76.–	26.–	7.2	3.1	*52.7*	20.–	17.–

TABLE 2. MAYA (YUCATAN) SKULLS RECENT[1]

No.	Approx. age	Deformation	Vault:[2] Length	Vault:[2] Breadth	Bas-B. Height	Cephalic index	Mean height index	Cranial module	Capacity in c.c.	Thichness ofl. parietal above and aong the t-p suture	Face: Menton-nasion	Face: Alveol. Pt.-nasion	·Diam. bizyg. max.	Facial index, total	Facial index, upper	Diameter: Basion-alveol. pt.	Diameter: Bas.-nasion	Frontal min.
Males																		
225,133	60	—	17.4	14.5	12.2	*83.3*	*76.5*	14.70	1430	3–5	—	—	13.8	—	—	—	9.5	9.3
244,017	70	—	17.–	14.6	12.8	*85.9*	*81.–*	14.80	1400	3–5	—	—	14.1	—	—	—	9.6	9.9
Females																		
225,134	24	—	16.3	13.6	12.4	*83.4*	*82.9*	14.10	1220	3–5	—	7.1	12.2	—	*58.2*	9.15	9.–	9.1
·244,016	45	trace (not enough to affect meas's)	16.7	14.5	11.6	*86.8*	*74.4*	14.27	1260	3–5	—	6.8	13.1	—	*51.9*	10.–	9.4	9.2
244,019	35	—	15.8	14.1	11.6	*89.2*	*77.6*	13.83	1105	4–6	—	6.–	13.2	—	*45.4*	9.7	9.–	8.9
Children																		
244,021	Child	—	15.–	13.5	10.6	*90.–*	*71.9*	13.03	—	2–4	—	—	—	—	—	—	—	—
244,018	"	—	14.3	12.9	10.–	*90.2*	*73.5*	12.40	—	2–3	—	—	—	—	—	—	—	—
244,020	"	—	15.6	14.3	11.6	*91.7*	*77.6*	13.83	—	2–4	—	—	—	—	—	—	—	—

[1]From a tumulus near the pueblo of Fixpehual, Yuca (Coll. by E. A. Lever).
[2]All methods as in author's "Anthropometry," 1920.

The main figures bearing on the above points are given in the accompanying table (Table 1).

The differences just shown are sufficient to separate the two groups into two distinct though in some respects similar types. Of these the coastal type, or that of the Cunas is the more pronounced as well as more homogeneous in the form of the head. Among the Chocos the range of the cephalic index, particularly among the males, is so great (74.7–89.1) that some mixture with the coastal type seems probable.

Of the two types of the eastern Panaman Indians here shown, that of the coast is particularly interesting. It is a short, sturdy, round-headed type with characteristic physiognomy. They are of about medium brown color, have straight black hair, scraggy beard or mustache, and but little hair on the body. The forehead is generally more or less sloping, eyeslits are commonly perceptibly oblique, the nose in the males is as a rule convex, the malars relatively large and rather prominent, the lips medium to above medium in thickness, and the lower part of the face rather short and not heavy. In all of these characteristics they much resemble the Indians of the San Blas coast, with whom in fact they appear to be identical.[3] But what is even more noteworthy is that in general this type appears to be close to that of the Mayas of Yucatan, so close as to constitute a strong suggestion of original identity of the two groups. Regrettably there are still lacking adequate measurements on the Maya people, both living and those of the far past. However, portraits of the present Mayas agree remarkably with those of the people of the northern Panaman coast and the measurements of 8 recent Maya skulls of the U. S. National Museum collections show the same essentials as seen in the Cuna tribes of Panama, namely marked brachycephaly and low vault with a rather short lower facial region (Table 2):

FURTHER MEASUREMENTS. ALBINOS.

In the latter part of 1924 Mr. Marsh brought eight of the San Blas Indians to Washington. Five of these were adults and of normal pigmentation; three were adolescent and "white." Two of the adults were parents of one of the "white" subjects. At the request of Mr. Marsh I took careful measurements and such observations as were possible on all these Indians in my Laboratory in the U. S. National Museum. The data obtained follows in detail.

[3]See Pinart (Alphonse)—Les Indiens de l'État de Panama. *Rev. d'Ethnogr.*, Paris, 1887, VI, 33–56, 117–132; with references to other publications. (Article of a general ethnographical nature dealing especially with the Cunas but also slightly with the Chocos, and mentioning the frequency of albinos among the coast Indians.)

The conclusions arrived at may be stated very briefly. Of the adults none differs to any important degree from the coast (Cuna) Indians at large, as shown by Baer's measurements; and the three "white" adolescents show no important aberration from the full-colored adults. If there are any significant physical differences in the apigmented of the San Blas territory, they ought to be determined by a study of the adults. As to the nature of the "whites" it may be said positively that they show no trace of any influence of white man, nor are they any normal racial mutants; they are just plain, and that more or less imperfect, albinos. This conclusion agrees independently and fully with that of Shrubsall, Haddon and Buxton (see Bibliography).

It may be of interest to append here the first somewhat circumstantial report on the Panama albinos, published in 1699 by Wafer:

A New Voyage and Description of the Isthmus of America. By Wafer (Lionel); edited by Geo. Parker Winship (repr. orig. ed. 1699), Cleveland, 1903, p. 133–136.

"There is one Complexion so singular, among a sort of people of this Country that I never saw nor heard of any like them in any part of the World. The Account will seem strange, but any Privateers who have gone over the Isthmus must have seen them, and can attest the main of what I am going to relate; tho' few have had the opportunity of so particular an Information about these People as I have had.

They are White, and there are of them of both Sexes; yet there are but few of them in comparison of the Copper-colour'd, possibly but one to two or three hundred. They differ from the other Indians chiefly in respect of Colour, tho' not in that only. Their skins are not of such a White as those of fair People among Europeans, with some tincture of a Blush or Sanguine Complexion; neither yet is their Complexion like that of our paler People, but 'tis rather a Milk-white lighter than the Colour of any Europeans and much like that of a white Horse.

For there is this further remarkable in them, that their Bodies are beset all over, more or less, with a fine short Milk-white Down, which adds to the whiteness of their Skins; for they are not so thick set with this Down especially on the Cheecks and Forehead but that the Skin appears distinct from it. The Men would probably have white Bristles for Beards, did they not prevent them by their Custom of plucking the young Beard up by the Roots continually; but for the Down all over their Bodies, they never try to get rid of it. Their Eye-brows are Milk-white also and so is the Hair of their Heads, and very fine withal, about the length of six or eight Inches and inclining to a Curl.

They are not so big as the other Indians, and what is yet more strange, their Eye-lids bend and open in an oblong Figure, pointing downward at the Corners, and forming an Arch or Figure of a Crescent with the Points downwards. From hence and from their seeing so clear as they do in a Moon-shiny night, we us'd to call them Moon-ey'd. For they see not very well in the Sun, poring in the clearest Day; their Eyes being but weak and running with Water if the Sun shine towards them; so that in the Day-time they care not to go abroad, unless it be a cloudy dark Day. Besides they are but a weak People in comparison of the other, and not very fit for Hunting or other laborious Exercise, nor do they delight in any such. But not-

MEASUREMENTS OF FIVE ORDINARY AND THREE ALBINO INDIANS FROM THE SAN BLAS TERRITORY, PANAMA

	Normally Pigmented					Albino		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Name	Iquaneede wipi	Alfred Robinson	Philip Thompson (Niga)	Jim Bary	Alice Bary (Mimi Tumba)	Olo Piniginia	Chipu	Margaret Bary
Sex	Male	Male	Male	Male	Female	Male	Male	Female
Approximate Age, years	Abt. 35	Abt. 28	Abt. 28	Abt. 40	Abt. 35	Abt. 17	Abt. 10	Abt. 15
Tribe and Connections	A San Blas Chief	Son of Chief, Nelli, Porto Gr'de	"Caribe-Cuna"	Father of 8 San Blas	Mother of 8 San Blas	Alligandi, San Blas	Porto Gr'de, San Blas	Daughter of 4 and 5, San Blas
Observations:								
Color of skin	above medium brown (uniform)	medium brown (uniform)	medium brown (uniform)	medium brown (uniform) (nof trace or suggestion of albinism)	sl. submedium brown (uniform) (no trace or suggestion of albinism)	ruddy white, with tan splotches (all over, but most on back, less on front and face, least on legs; on back approx. 100 spots, irregular, 2 to 20 mm. in diam.); plainly some symmetry in splotches. larger splotches look like liver spots, but with less demarkation of contours	somewhat (but not clean) white, tendency to ruddiness	as in somewhat florid whites symmetric, irregular, moderately brownish patches (the brown of freckles) dorsally on forearms (body not examined)

Color of eyes	very dark brown	dark brown	very dark brown	dark brown	near dark brown	grey with bluish tinge, brown about pupil	slate blue, brown about pupil	grey, brownish about the iris
Hair: Form	straight	straight	straight	straight	straight	straight	straight	straight
Coarseness	medium coarse	medium coarse	medium coarse	medium coarse	medium coarse	medium coarse	medium	medium
Color	black	black	black	black, few grey	black	light (straw) yellow	light yellowish	pale yellowish sl. darker near the scalp and in back
Eyelashes	black	black	black	black	black	almost white	almost white	almost white
Beard	sparse, only over corners of mouth, abt. 1.5 cm. long; some stubble on chin	none	shaved—stubs show a fair amount of moustache no trace on sides of face	cut—a fair quantity of moustache and on chin, none on sides	—	—	—	—
Forehead: Height	somewhat low	somewhat low	medium	medium	medium	medium	low	medium
Slope	normal	normal	sm. sloping	marked slope	normal	sm. sloping	normal	normal
Supraorbital Ridges	submedium (for a male)	submedium	moderate	somewhat above medium	somewhat above medium (for a female)	very moderate	nearly —	slightly above medium
Eyeslits	outer canthi very perceptibly higher than inner	outer canthi sm. higher	outer canthi sm. higher	outer canthi left sl., right sm. inclined upward	nearly as in whites	outer canthi higher	outer canthi sm. higher	outer canthi sm. higher, esp. right
Malars	not unduly prominent (face rather full)	somewhat prominent	prominent	large	large	sm. above medium	not prominent	large
Nasal root depression	submedium	shallow	shallow	medium	sm. shallow	medium	wide	sm. shallow

MEASUREMENTS OF ALBINO INDIANS.—*Continued*

	Normally Pigmented					Albino		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Name	Iquaneedewipi	Alfred Robinson	Philip Thompson (Niga)	Jim Bary	Alice Bary (Mimi Tumba)	Olo Piniginia	Chipu	Margaret Bary
Nose (Bridge)	straight	straight	straight	straight, rather low	sl. convex	sl. convex	straight	sl. concavo-convex, rather low
Nasal septum	horizontal	sm. inclined upward	sl. inclined upward	sm. inclined upward	considerably inclined downward	horizontal	horizontal	near horizonta
Lips	sm. thick	above medium	above medium	sm. above medium	sm. above medium	above medium	sm. above medium	sm. thick
Sex	Male	Male	Male	Male	Female	Male	Male	Female
Alveolar prognathism	above medium	above medium	rather marked	rather marked	sm. above medium	above medium	sl. noticeable	sm. above medium
Chin	medium	medium	medium	medium	medium	medium	medium	medium
Angles of lower jaw	large	sm. prominent	medium	large	rather large	sm. large	medium	medium
Body and limbs	normal, but rather sl. submedium	normal, sl. submedium	normal	normal, rather stocky	normal	normal	normal	normal, well nourished
Breasts	—	—	—	—	medium, full	—	—	moder., virg., conical
Special	—	—	—	—	—	Nystagmus (continuous when examined)	Nystagmus, marked, continuous during examin.	Moderate nystagmus, continuous during examin. of eyes

Pl. I

Upper: Darien Indian Family with their Albino Baby.
Lower: Margaret, Olo (right) and another Albino Boy. (Photos by R. O. Marsh.)

Pl. II.

"White" Indians at Aligandi, San Blas Coast, Panama. (Photo by R. O. Marsh.)

Measurements:								
Head	normal	normal	normal	normal	normal	normal	normal	normal
Stature, cm.	154.1	152.3	154.1	157.2	156.3	148.6	140.4	152.2
Weight (reduced to nude) lbs.	115.5	110.5	121	151	135	102	76	121
gms.	*52,389.92*	*50,121.96*	*54,884.68*	*68,492.46*	*61,234.98*	*46,266.43*	*34,473.02*	*54,884.68*
Ht.-Wt. index $\left(\frac{\text{wt. in grams}}{\text{Stature in cms.}}\right)$	*340.–*	*329.1*	*356.2*	*435.7*	*391.8*	*311.3*	*245.5*	*60.6*
Max. finger reach	164.3	166.–	159.7	167.3	165.5	157.3	145.–	157.3
Fing. reach *vs.* stature (S=100)	*1.07*	*1.09*	*1.04*	*1.06*	*1.06*	*1.06*	*1.03*	*1.03*
Height, sitting	81.–	81.1	85.4	83.5	84.3	81.1	74.3	81.1
Trunk index $\left(\frac{\text{H S} \times 100}{\text{S}}\right)$	*52.6*	*53.2*	*55.4*	*53.1*	*53.9*	*54.6*	*52.9*	*53.3*
Lower limb index $\left(\frac{\text{H. of L.L.'s} \times 100}{\text{S}}\right)$	*47.4*	*46.8*	*44.6*	*46.9*	*46.1*	*45.4*	*47.1*	*46.7*
Head:								
Length max.	19.8	18.6	19.4	19.3	18.8	18.6	18.2	18.2
Breadth max.	16.3	15.3	16.4	16.6	16.–	15.5	16.3	16.2
Height (bas.-bg.)	12.4	12.6	12.1	12.5	12.3	12.4	12.2	12.–
Cephalic index	*82.3*	*82.3*	*84.5*	*86.–*	*85.1*	*83.3*	*89.6*	*89.–*
Mean height index $\left(\frac{\text{H} \times 100}{(\text{L}+\text{B}) \div 2}\right)$	*68.9*	*74.1*	*67.6*	*69.4*	*70.7*	*72.9*	*70.9*	*69.8*
Cephalic module, (mean)	*16.17*	*15.50*	*15.97*	*16.13*	*15.70*	*15.50*	*15.57*	*15.47*
Cephalic module *vs.* Stature, $\left(\frac{\text{cm.} \times 1{,}000}{\text{S}}\right)$	*104.9*	*101.8*	*103.6*	*102.6*	*100.4*	*104.3*	*110.9*	*101.6*

MEASUREMENTS OF ALBINO INDIANS.—*Concluded*

	Normally Pigmented					Albino		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Name	Iquaneede wip i	Alfred Robinson	Philip Thompson (Niga)	Jim Bary	Alice Bary (Mimi Tumba).	Olo Piniginia	Chipu	Margaret Bary
Face:								
Height to nasion	12.6	12.2	12.9	12.4	12.–	11.7	11.3	11.8
Height to crinion	19.–	18.2	19.6	(some hair lost)	18.–	17.4	17.3	18.3
Diam. bizygom. max.	14.5	14.3	14.6	14.9	14.7	14.–	13.7	13.8
Facial index, anatomic	*86.9*	*85.3*	*88.4*	*83.2*	*81.6*	*83.6*	*82.5*	*85.5*
Facial index, physiognomic	*76.3*	*78.6*	*74.5*	—	*81.7*	*80.5*	*79.2*	*75.4*
Diam. frontal min.	11.2	10.–	11.–	11.–	11.–	10.3	10.3	11.–
Diam. bigonial	10.8	10.5	10.1	10.2	11.–	10.4	9.9	10.8
Nose:								
Length	5.3	5.8	5.6	5.4	5.4	5.1	4.8	5.2
Breadth	4.1	3.9	3.9	4.1	3.9	3.65	3.7	3.8
Index	*77.4*	*67.2*	*69.6*	*75.9*	*72.2*	*71.6*	*77.1*	*73.1*
Mouth: Breadth	5.8	5.6	4.7	6.1	5.7	5.6	5.2	5.5
Left ear:								
Length	6.4	5.5	6.2	6.7	6.4	6.3	5.7	5.7
Breadth	3.9	3.6	3.7	3.8	3.9	4.1	3.5	3.8
Index	*60.9*	*65.4*	*59.7*	*56.7*	*60.9*	*65.1*	*61.4*	*66.7*
Chest:								
Breadth	29.8	27.7	30.7	31.4	29.9	28.1	22.6	27.5
Depth	19.7	20.3	19.7	22.6	21.5	19.2	16.8	19.8
Index	*66.1*	*73.3*	*64.2*	*72.–*	*71.9*	*68.3*	*74.3*	*72.–*

Sex	Male	Male	Male	Male	Female	Male	Male	Female
Left hand:								
Length	18.–	17.5	16.7	18.3	18.3	16.9	15.6	17.2
Breadth	6.8	8.5	8.3	9.1	8.6	8.2	7.4	8.–
Index	*37.8*	*48.6*	*49.7*	*49.7*	*47.–*	*48.5*	*47.4*	*46.5*
Left foot:								
Length	24.9	22.5	22.7	24.5	23.3	23.2	21.8	23.5
Breadth	9.3	9.2	9.3	9.6	8.7	9.–	8.3	9.2
Index	*37.3*	*40.9*	*41.–*	*39.2*	*37.3*	*38.8*	*38.1*	*39.2*
Physiological:	—	[1]	[1]	[1]	[1]	—	—	[1]
Pulse	(constip.)	74	84	78	88	(tongue sm. coated)	(do)	78
Respiration	—	18	19	20	15	—	—	18
Temperature	—	36.6	37.1	37.1	37.6	—	—	37.5
Strength:								
Pressure, r. hand kg.	30.5	35.5	31	31.5	29.– (left-handed)	22.5 (right handed)	12.– (r. h'd)	13 (left handed)
l. hand	28.5	33.–	25	31.–	29.5	22.5	12.–	17
Traction	17.–	22.–	17	29	—	14.–	6.–	11
Notes	—	—	—	—	Bore 7 children, 4 dark, 3 white: 1st ♂, brown, dead; 2nd ♂, white, dead; 3rd ♀, white, dead, 4th ♂, brown, liv'g; 5th ♂, brown, liv'g; 6th ♀, white =No. 8; 7th ♂, brown, dead; also 2 miscarriages, color?	No hair in axillae, pubic hair very light in color A supernumerary tooth, back of left med. upp. incisor	Long colorless lanugo on forearms, less on body. Splotches (color of liver-spots), on face, small here and there over front of body, many over the back, some (but not great) symmetry.	— (body could not be examined)

[1]Well, but tired.

withstanding their being thus sluggish and dull and restive in the Day-time, yet when the Moon-shiny nights come, they are all Life and Activity, running abroad, and into the Woods, skipping about like Wild-Bucks; and running as fast by Moon-light, even in the Gloom and Shade of the Woods, as the other Indians by Day, being as nimble as they, tho' not so strong and lusty.

The Copper-colour'd Indians seem not to respect these so much as those of their own Complexion, looking on them as somewhat monstrous. They are not a distinct Race by themselves, but now and then one is bred of a Copper-colour'd Father and Mother; and I have seen a Child of less than a Year old of this sort. Some would be apt to suspect they might be the Off-spring of some European Father: but besides that the Europeans come here little, and have little Commerce with the Indian-women when they do come, these white People are as different from the Europeans in some respects as from the Copper-colour'd Indians in others. And besides, where an European lies with an Indian-woman, the Child is always a Mostese or Tawney, as is well known to all who have been in the West Indies; where there are Mostesa's, Mulatto's etc. of several Gradations between the White, and the Black or Copper-colour'd according as the Parents are; even to Decompounds, as a Mulatto-Fina, the Child of a Mulatto-man and Mostesa-women etc.

But neither is the Child of a Man and Woman of these white Indians white like the Parents, but Copper-colour'd as their Parents were. For so Lacenta told me, and gave me this as his Conjecture how these came to be White, That 'twas through the force of the Mother's Imagination, looking on the Moon at the time of Conception; but this I leave others to judge of. He told me withal, that they were but short-liv'd."

Remarks: Shorn of the sensational, the frequent occurrence along the northern coast of Panama, since centuries, of albinism now brought more closely to our attention by Mr. Marsh, who deserves the thanks of science for this service, is a patho-biological phenomenon of much interest, and the subject deserves a most thorough investigation from all points of approach.

SUMMARY

Anthropological study of the "white" and other Panama Indians brought to Washington by Marsh indicates (a) that the "white" Indians are simply albinos; (b) that the dark ones represent an interesting American type which is apparently the same with that of the Mayas to the north and the Yungas to the south; and (c) that the two groups "white" and brown, show no substantial somatic differences except in pigmentation and conditions directly associated with same.

A further anthropometric study of the Indians of the Gulf of Darien shows the presence of two types, the coastal related to that of the Maya and the more interior one, though admixed, related apparently to either the Aztec or the Arawak type.

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THE SAN BLAS INDIANS

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WHITE INDIANS

Many and varied have been the reports of the occurrence of "White Indians" in southern Central and South America. Frequently these reports have been considered true in individual cases, but the existence of a group or of groups of white Indians with fixed inherited characteristics, carried from generation to generation in the germplasm and expressed in the somatoplasm, clearly differentiating them from other Indians, forming a type which reproduces itself with slight variation about a fixed mean, a group occupying a definite geographical area; in short any report of the existence of "a race of white Indians" has met, almost without exception, with disbelief and skepticism if not ridicule.

PREVIOUS REPORTS

"The Darien albinotic race has a fairly long history.[1] Raynal in his Histoire philosophique et politique des établissmens .... dans les deux Indes (T. III. p. 154, Edn. 1774), speaking of Vasco Nunez de Balboa going to Darien, writes: 'Le pays lui offrit d'abord de ces petits hommes blancs dont on retrouve l'espèce en Afrique, and dans quelques isles de l'Asie. Ils sont couverts d'un ducet d'une blancheur éclatante. Ils n'ont point de cheveux. Ils ont la prunelle rouge. Ils ne voyent bien que la nuit. Ils sont foibles, and leur instinct paroît plus borné que celui des autres hommes.' N. Robertson, History of America, Vol. II. 4th Edn. p. 68, speaks of the Darien albinos as a race. Cossigny (1760)[2], speaking to the French Academy of Sciences, states that a number of travellers have come across the race in 'a district not far from Mexico.' He describes it as a nation entirely of white men, white haired, who cannot endure broad daylight without great pain, We have not been able to follow up the tradition to its ultimate source, which would probably be found in the accounts of the early Spanish navigators.

"A fairly truthful report of the actual state of affairs at Darien is however given by Wafer[3], whose whole method of writing strikes us as very creditable and credible for the period. Wafer first took to the sea as a surgeon's boy in 1677 and visited Darien with Dampier in 1681. Wafer was perhaps the first "Naturalist" to go on an exploring ship.

[1]Pearson, K., Nettleship, E. and Usher, C. H., A Monograph on Albinism in *Man*, London, 1911. Text, Part I, 16–18, and 105.

[2]Cossigny, Histoire de l'Acad. des Sciences de Paris. 1774, 13, and 1760, 17 (published 1766).

[3]Lionel Wafer, a New Voyage and Description of the Isthmus of America, giving an Account of the Author's Abode there. 3rd. Edn., London, 1729. *Coll. of Voyages*, III, 8vo, 261–463.

Am. J. Phys. Anthrop., 1926, Vol. IX, No. 1.

He seems to have had a very considerable power of observation, giving a long, and, for the age, reasonable account of birds, beasts, snakes, fish, etc., in a section of his work termed On the Natural History of these Parts. On p. 346 of his Description he speaks of the 'White Indians' as follows:

'There is one Complexion so singular among a Sort of People of this Country that I never saw nor heard of any like them in any Part of the World. The Account will seem strange; but any Privateers who have gone over the Isthmus must have seen them, and can attest the main of what I am going to relate, though few have had the opportunity of so particular an Information about these people as I have had.

They are white, and there are of them both Sexes; yet there are but few of them in Comparison of the Copper-colour'd, possibly but 1 to 2 or 300. They differ from the other Indians chiefly in Respect of Colour, though not in that only. Their Skins are not of such a White as those of fair People among Europeans, with some Tincture of a Blush or Sanguine Complexion; neither yet is their Complexion like that of our paler People, but 'tis rather a Milk-white, lighter than the Colour of any Europeans, and much like that of a white Horse.

For there is this further remarkable in them, that their Bodies are beset all over, more or less, with a fine short Milk-white Down, which adds to the Whiteness of their Skins: for they are not so thick-set with this Down, especially on the Cheeks and Forehead, but that the Skin appears distinct from it. The Men would probably have white Bristles for Beards, did not they prevent them by their Custom of plucking the young Beard up by the Roots continually: but for the Down all over their Bodies, they never try to get rid of it. Their Eye-brows are Milk-White also, and so is the Hair of their Heads, and very fine withal, about the Length of 6 or 8 Inches, and inclining to Curl.

They are not so big as the other Indians; and what is yet more strange, their Eye-lids bend and open in an oblong Figure, pointing downward at the Corners, and forming an Arch or Figure of a Crescent with the points downwards. From hence, and from their seeing so clear as they do in a Moon-shiny Night, we us'd to call them Moon-ey'd. For they see not very well in the Sun, poring in the clearest Day; their Eyes being but weak, and running with Water if the Sun shine towards them; so that in the Day-time they care not to go abroad, unless it be a cloudy dark Day. Besides, they are but a weak People in Comparison of the other, and not fit for Hunting or other laborious Exercise, nor do they delight in any such. But notwithstanding their being thus sluggish, and dull, and restive in the Day-time, yet when Moon-shiny Night's come, they are all Life and Activity, running abroad, and into the Woods, skipping about like Wild-Bucks; and running as fast by Moonlight, even in the Gloom and Shade of the Woods, as the other Indians by Day, being as nimble as they, tho' not so strong and lusty.

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bred of a Copper-coloured Father and Mother; and I have seen a Child of less than a Year old of this Sort. Some would be apt to suspect they might be the Offspring of some European Father: But besides that the Europeans come little here, and have little Commerce with the Indian-Women when they do come, these white People are as different from the Europeans in some Respects, as from the Copper-colour'd Indians in others. And besides, where an European lies with an Indian-Woman, the Child is always a Mostese, or Tawney, as is well known to all who have been in the West Indies; Where there are Mostesas, Mullattos, of several gradations between the White, and the Black or Copper-colour'd according as the Parents are; even to Decompounds, as a Mullatto-Fina, the Child of a Mullatto-Man, and a Mostesa woman, &c.

But neither is the Child of a Man and Woman of these white Indians, white like the Parents, but Copper-colour'd as their Parents were. For so Lacenta told me, and gave me this as his Conjecture how these came to be white, that t'was through the Force of the Mother's Imagination, looking on the Moon at the Time of the Conception; but this I leave others to judge of. He told me withal, that they were but short-liv'd.'

We venture to think that in the Isthmus of Darien we have again a case of numerous albinos appearing on the borders of two races, and a possible instance of segregative effect. Wafer's account is so transparently honest that we might even venture to believe that, for man, albino mated with albino will not invariably give albinotic offspring. Close on either side of the Isthmus of Darien we find other traditions of albinotic races, the one from Brazil and the second from Mexico.

Dr. Cullen in his Isthmus of Darien Ship Canal[4] of 1853 mentions two albino children on Perdon Island off Cape San Blas . . . . . The island is not marked on two maps we have examined, but Point San Blas is the western extremity of the Gulf of Darien."

Further, just at the head of the gulf, Viguier[5] (1877) has studied the Indians of Paya. They are Cunas and belong to the great family of the Caribbeans. He saw only a single case of albinism. "The subject was a woman of middle age (d'un certain age), whose eyes were red, the skin not absolutely light (a peine plus claire), and the hair red, mixed with white." Viguier seems to have been uncertain of her complete albinism, but the redness of the eyes is probably decisive when we remember the red and yellow hair and the freckled skin of most dark-race albinos.

V. Forbin in a paper on a white negro[6] also refers incidentally to the village of Paya. He says that he had been able to count there a dozen albinos in a population of 200 persons. The albino women did not like to leave their houses in bright daylight; the albino men went with their comrades to the chase, but appeared to be less skilful hunters than the others. He gives no personal details."

[4]Cullen. Isthmus of Darien Ship Canal. London, 1853. 74.
[5]Viguier, C. Notes Sur Les Indiens de Paya. *Mem. Soc. d'Anthrop.* Paris, 2e sér., 1877, I., 412.
[6]*La Nature*, 37 annee, 1909, 384.

MARSH'S ACCOUNT

In June 1924, however, a report of the existence of a racial group of white Indians was brought from Darien to the rest of the world by Mr. R. O. Marsh, engineer and explorer. This report, in several aspects, seemed decidedly better substantiated than many others had been. Mr. Marsh had just returned from a trip of exploration in Darien, during which he had crossed the Isthmus of Panama from Yavisa on the River Tuyra to Caledonia on the San Blas coast: a journey which had taken him through regions practically unknown to persons other than Indians. Upon his return to North America he brought with him seven Indians of whom three were white. These he presented, together with a revised and amplified map of the region, based upon his own observations and upon reports gleaned from natives, as evidence of the existence of the racial group already mentioned.

The map indicated the presence of groups of white Indians in and just behind the San Blas coastal range of mountains, these groups extending from the limits of the Walla territory on the east to the Rio Diablo del Sud to the west, a region embracing many of the headwaters of the Chucunaque and the Bayano rivers.

The presence of these groups of white Indians in a definite geographical area and in settlements made up entirely of their own kind was explained by Mr. Marsh by the statement that for some time, from just after the maltreatment of the Indians by the Spanish Conquistadores to very recently, the Indians with white skin had been held in disrespect and dislike by normally pigmented Indians and had been exiled from their settlements upon reaching maturity. The exiles had retreated to the mountain fastnesses where they had lived in safety, reproducing their kind and thus forming a racial group, the number of individuals of which was increased by births within the group and by the arrival of new exiles. The region of their retreat, already described, came to be known as the White Indian country. Mr. Marsh's statement, as sent out by Science Service Inc., is as follows:

Outlines for Four-column Map. "Here is where the White Indians live. They occupy a segregated district on the southern slope of the main San Blas range. They number about one thousand. This territory is never entered by brown Indians. They are large, very powerful, and looked upon with fear and awe by the surrounding brown Indians ......"

"Separate and distinct from the brown San Blas Indians, yet a part of them, the White Indians seem to be both outcasts and a dominant

people. The brown San Blas Indians occupy the Atlantic coastal region and the numerous coral islands off the shore. Beyond the mountains, 15 to 20 miles distant from the shore is the territory of the White Indians who occupy the higher regions of the southern slope. Their land is held inviolate to the brown, likewise the whites are denied permission to live in the brown settlements. Years ago before the Spaniards arrived in the New World, white and brown lived together, so the Indian legend runs. The Spaniard was welcomed to the new land, but soon his mistreatment of the natives caused them to turn against him and expel him from the country. The hatred of the Indians for the white man was so violent that it extended to their own whites who were forced to live apart. The laws forbid intermarriage of whites and browns."

In the Canal Zone and in Panama city the validity of Mr. Marsh's statement was seriously questioned. Traders and others had visited various islands off the San Blas coast, some were in residence in trading ships anchored off several of the islands and had seen white Indians from the island and coastal villages where they were said to appear infrequently in the population, and were considered albinoes. The report of villages comprised of white Indians only, and of a geographical area where white Indians alone were to be found was generally ridiculed. But the attitude of the Panaman traders did not receive wide circulation in the United States and Canada whither Mr. Marsh took the seven Indians, previously mentioned, that they might be examined by scientists.

OPINIONS OF SCIENTISTS

Among the views set forth by the examining scientists the following deserve mention.

A strong group of American anthropologists including Drs. Hrdlička, Wissler and Sullivan declared that the white Indians in question were apparently albinoes, pointing out the similarity between the individuals at hand and the albinos of the Zuni Indians of the south-western United States.

Hrdlička based his opinions upon his previous studies of albinism in Indians, described in the following:[7]

"In studying the defects of pigmentation we meet with two apparently related classes of phenomena. One is a regular, more or less complete and extended congenital lack of the usual pigmentation, or what may be termed albinism proper; the other being a generally irregular, more or less incomplete and extended, depigmentation occurring at some period during life, and known more commonly as vitiligo. Both of

[7]Hrdlička, A., Medical & Physiol. Studies among Indians. *Bull. 34, Bur. Am. Ethnol.*, 1908, 192 ff.

these conditions, originally probably neuropathic, yet seemingly radically different, were met with among Indians visited, but in the southwestern United States the cases found are comparatively few in number and restricted to a few tribes, while no instance of either condition was encountered among the Mexican Indians, with the exception of the Tarahumare, among whom an albino was found by Hartman, and possibly the Mayo, among whom are said to occur, far down the Mayo river, individuals with light hair, skin, and eyes. The Mexican Indians are much scattered, however, and all detailed inquiry is very difficult.

"Among the Hopi and the Zuni albinism has been known since early historic times, and apparently shows no tendency toward either a marked increase or a marked diminution. The writer learned of one case of complete albinism among the Navaho and of another at Isleta, besides which he saw a woman 50 years of age, a partial or atypical albino (yellow hair, but moderately brown skin), among the Southern Ute, and a case of vitiligo in a male Papago of about 55 years. Finally, in four full-blood Mohave girls at the Fort Mohave school were seen lighter, but not quite vitiligo-like, spots on the exposed portions of the otherwise normal-looking skin.

"The writer made it a point to see all the albinos among the Hopi, and was able to measure all but one as well as to inquire somewhat into their family histories, for at the present time the condition is doubtless propogated to some degree through heredity. Among the Zuni he was able to examine but two of the men. . . . As the Hopi and Zuni tribes are closely related physically and as the albinism occurring among them is of the same nature, the data relating to them will be presented conjointly.

"The writer found among the Hopi (March, 1900) 11 and among the Zuni (same year) 6 albinos. The proportion to the whole population was 5.5 per thousand among the Hopi and 3.8 per thousand among the Zuni.

Of the Hopi albinos, 3 were males and 8 females; of the Zuni, 3 were males and 3 females; total, 6 males and 11 females. Nine out of the total 17 albinos were children, 8 adults. All 17 were complete albinos, but of slightly different shades. There was found in the two tribes no instance of partial albinism or vitiligo.

"The general appearance of the albinos in both tribes was much alike. Their physiognomy, irrespective of their slight variant color, differed from that of the other Indians. Their skin seemed to be of ordinary texture, but more sensitive to exposure than in the full colored. It was pink or white with a slight flush, and the exposed parts usually showed a more or less pronounced sun discoloration, much like ordinary sunburn among the whites. On the body the skin looked absolutely normal; on the face, neck and hands, in the adults, however, it was rather rebundant and wrinkled, or in folds, giving these parts in some cases myxedematous-like appearance. The lips were in many somewhat irregular, exfoliating, cracked or sore.

"The hair ranged in color from that of the unbleached flax fiber (pale yellowish) through various shades of yellowish and brownish—

always with a slight golden luster—to medium brown. In no instance was there any trace of red in the hair. The eyebrows and eyelashes as a rule were lighter than the hair, in some cases practically colorless. The consistency and quality of the hair showed no features strikingly different from those found in ordinary Indians of the same tribes.

"The eyes were light gray or light blue to moderate gray-blue, with sclera white—very much like eyes of similar shades in blond white people. In no case was the iris colorless, with pink reflection, as in the albino rabbit. In every instance there was a more or less marked nystagmus and heliophobia. The vision was not strong, but short-sightedness was not noticed.

"Owing to the blinking eyes and the more or less abnormal skin, the face was generally somewhat sheepish in expression, reminding one of the faces of some epileptics. In most of the adults the nose was thicker than the average, while in the majority of cases the lips were thickened, and as already mentioned, somewhat irregular in shape. These conditions are undoubtedly very largely the effects of irritation by wind and sun. In four cases the teeth were somewhat crowded or irregularly set. In one of the Zuni men half of the teeth had been lost. In no case was there found any decided retardation in dentition or any anomalies of the teeth. The palate was in all fairly regular.

"Measurements of the body showed that neither the children nor the adults differ much from normal individuals of similar age and full color. In no instance were there seen signs of scrofula, congenital syphilis, or rachitis. The pulse, respiration, and temperature of two of the albinos, who were in perfect health, approached closely the average of the tribe; in other individuals these tests were interfered with by various minor disorders. All those, however, who could be tested for strength by the dynamometer were found to be weaker than average full-colored individuals of the same age in the same tribe.

"Among the Hopi the albinos are known as ko-lo-ko-cha-te (white people). Neither among the Hopi nor among the Zuni are they ostracized or looked on as inferiors. They marry full-colored individuals of the other sex, but they themselves are generally ashamed of their condition. They are not inclined to play or to take part in the life of the village as others do. In associating with them the writer found all of them to be sensitive, bashful and easily irritated or made to cry. With two exceptions among the men, they appeared from slightly to moderately submedium in intelligence; the testimony of teachers and others agreed with this conclusion.

"An inquiry into the family history of an Indian is seldom very satisfactory. According to the scanty and perhaps not always reliable data obtainable, in most instances the albino is the second child of the mother; in one case he was the third; in one case the eighth (last). In the nine cases (children) here considered the father, the mother, and all the other children were of normal color. In one family the second and sixth children were albinos; in one family the second and third; and, finally one woman had three children, all albinos. In all these in-

stances, the father, mother, and remaining children, where such existed, were full-colored. The albinos married to full-colored individuals seldom raise any, and never large, families of their own. This point seems of importance and needs further attention. The Indians have no rational idea as to the cause of albinism, and have not noticed that it runs in certain families.

"There is among the Hopi considerable intermarriage of distant relatives, but marriage is regulated by the clan system, which prevents all close interbreeding; on the whole this factor is not greater or even as great as in some still smaller tribes, for example, the Maricopa, among whom no albinism has been recorded. There are indications that the actual, original cause of the condition lies in the nervous centers, and is of a degenerative nature, being propagated in the tribe through hereditary influences. No definite clue as to any special predisposing or exciting cause has been found in connection with the series here reported. Prolonged lactation of the youngest in common with a previous child was considered, but this is frequent among all Indians and takes place with all the children in families where only single albinos occur. Careful and detailed observations in this line should be made in the future by the resident physicians in particular."

Certain pathologists gave indefinite answers, such as idiopathic leucoderma and a "non morbid pathologic condition," to insistent newspaper reporters.

Some geneticists, notably Prof. Huxley,[8] who examined the Indians at the Toronto meetings of the British Association for the Advancement of Science, came to the conclusion, in view of the data furnished, that the white Indians exhibited a condition due to a single gene mutation. He believed that the condition would be found to be inherited as a simple Mendelian recessive, and that, by consequence, the white Indians were homozygous recessives.

"In the first place, then, it appears clearly established that the "white" condition behaves as a simple Mendelian recessive. The normal dark colour is completely dominant; there are no intermediates; all the "whites" show essentially the same deviation from normal; white x white gives only whites, but whites may be produced (together with normals) from the mating of two persons phenotypically normal.

The condition has been described as "partial albinism." If by this is meant simply any condition in which normal pigmentation is reduced, the term is applicable; but it should be noted that these people possess yellow hair and hazel eyes.

All the authorities who have examined them are agreed that the condition has no racial significance: the racial type has not been altered save in the one respect of pigmentation, nor can the condition possibly be interpreted as resulting from previous crosses with Europeans

[8]Huxley, J. S. 1924. Mendelism and Evolution. *Nature*, CXIV, 464.

In any case, the discovery that the condition depends on a single-gene Mendelian difference from the normal implies both these results.

Now, however, for the biological and evolutionary significance. Not only are these "mutants" (as they clearly appear to be) perfectly capable of healthy existence and reproduction, but they are coming to form a community of their own. The normally-coloured members of the tribe have a feeling against marrying "whites," with the result that the mutants mate almost wholly with others like themselves, and thus in the course of time have formed a nearly closed, self-reproducing community of several hundred souls.

Mutation: consequent preferential mating: consequent establishment of a definite intra-specific unit: with the future consequence that any further mutation occurring within this unit will remain confined to it, and the difference between mutated and type stock thus become accentuated. Here, in man himself, is a case showing with almost diagrammatic clarity how evolutionary change may originate in single mutations of considerable magnitude."

PURPOSE OF PRESENT STUDY

Here the question stood when, upon the invitation of Mr. Marsh, a committee, consisting of Drs. Hrdlička, Davenport, and Stiles, was chosen to select a group of scientists to accompany Mr. Marsh upon another expedition to Darien and the San Blas to study the white Indians. This committee decided that the desired results could best be obtained by the combined efforts of a pathologist, an anthropologist and a geneticist. Among the appointments I was chosen to serve as geneticist to the expedition. Unfortunately the expedition in its original conception did not materialize, though I had the good fortune, with Mrs. Harris, to accompany Mr. Marsh from Colon to the San Blas, and there, thanks to his entré to the Indian villages, to engage in a study of the Indians in question during a period of about five weeks. A longer stay was rendered impracticable by the internal political situation of the region, which culminated, just after my departure, in a formal revolution. However, due to excellent cooperation on the part of the natives I was able to secure valuable genetical and anthropometrical data.

Among the questions which arose in the minds of biologists the following seemed to deserve special attention:

1) Is the condition: "white Indian," assured of permanency by being an inherited trait, carried in the germplasm from generation to generation and expressed in the somatoplasm whenever conditions are favorable?

2) If it is inherited, when and under what conditions does it find expression?

a) Is it, as Huxley thought, the expression of a simple Mendelian recessive mutation dependent for its expression upon a homozygous condition in respect to a single gene governing the characteristic?

3) Are there other inherited differences between white and brown Indians than skin color, eye color, and hair color?

4) Is there differential susceptibility to pathologic conditions between the two groups?

5) Are differential inherited traits grouped with normal slight variations around a constant mean, thus forming biotypes?

6) Do white Indians occur in a distinct geographical area or areas where permanent characteristics permit them to assume racial importance?

Other questions naturally arose in connection with the foregoing, and these, whenever possible, received and will be given attention.

DO WHITE INDIANS FORM A GEOGRAPHICALLY ISOLATED RACE?

Before entering upon a discussion of the first question, certain findings concerning the last question, in direct contradiction to the report carried by Mr. Marsh to North America, and bearing directly upon the whole question of the white Indians, should be considered.

Unfortunately no one of the expedition was successful in reaching the territory designated by Mr. Marsh on his map as the white Indian country. After some time we did succeed in obtaining from the chief of Alligandi, an island of the San Blas coast, permission to visit the interior, and the assurance of native porters and guides for the trip. These were provided and the next morning Mrs. Harris, Mr. Johnson and myself set out for Matoongandi, a town nearly in the center of the region said by Mr. Marsh to be the white Indian country. All went well until we had marched well up into the foothills of the San Blas range when our guide and porters refused to go further, offering many excuses which we met without avail. Thus we were forced to return to the coast where we learned that the friendly chief was, as we suspected, a party to the failure of the trip—the real reason being that the chief feared an immediate attack upon his island by the Panama police, the women and children were already departing for the brush, and we and our porters were wanted at the village for the added sense of security which our presence seemed to give.

But in spite of the fact that we were unable to visit the region in question, I am thoroughly convinced that there are no settlements composed solely of white Indians in that or any other region of the San Blas or Darien. This contention is based on the following facts:

There is no evidence for Mr. Marsh's main reason in support of the existence of such settlements, namely past and present exiling of the white Indians from villages inhabited by brown Indians.

In the villages of Carti, Chucumbale, Nagana, Playon Chico, Tupil, Alligandi, Banana, and Portogandi, all of which I visited, statements were made to the contrary without exception. The Indians, their doctors and chiefs, and such a reliable source of information as the missionary, Miss Coope of Nagana, as well as traders and Panaman officials, resident on some of the islands, all admitted that in previous times white Indians were sometimes killed at birth, but emphatically stated that they were never exiled and that no towns composed solely of white Indians existed, in the San Blas or in Darien.

Moreover, in the towns in which we lived and in those which we visited white Indians beyond the marriageable age were seen, and were observed by us to be permanent residents of these villages. (It will be recalled that Mr. Marsh stated that all whites were exiled upon reaching the marriageable age.) In Alligandi there lives a white woman of about forty, a white man of about the same age, two white men of about 25 to 30, a white man of about 22, and Olo who has reached the reproductive age. At Portogandi there lives a white Indian man of about forty. At Playon Chico there are two white Indian women residents. They are between 35 and 45 years of age. At Nagana there lives a white Indian woman of about thirty, and Maguerite has reached the marriageable age. At Carti I know of at least three adult white Indian men, one of whom I saw, the other two being away at the time of my visit. All of these mentioned, save the last two, I saw in their native villages, and in their family circles. None were married, but otherwise led the normal life of the community.

Reports of other white Indian adults, living in brown villages which it was impracticable for me to visit, reached me, and in view of the foregoing would seem to be reasonable and true. In fact, save for Mr. Marsh's statement, I have never heard of white Indians, adults or children, living elsewhere than in the villages of the browns, save for a few who have gone, like some of the browns, to work here and there on large plantations.

Furthermore, during the period in which white Indians were held in disrepute by the browns, infanticide was without doubt common, if not universal. This in itself would remove any necessity for segregation. It seems safe to conclude that exiling of whites is not and has not been practiced among the people of the San Blas.

During our stay at Alligandi we were visited by men from Matoongandi, Narrgandi and Seebooti, villages on three of the upper branches of the Bayano from which they take their names. These villages, previously unreported and not shown on any map, are in the heart of the "white Indian country." They are, furthermore, the only mountain villages in the large mountain area in direct communication with Alligandi. Men from these towns frequently visit Alligandi to attend regional congresses. We saw a total of about fifteen such men from these towns. All were brown. We became well acquainted with some of the men. An English speaking young man from Narrgandi, who as a sailor had visited much of the world told us that in his village, with a population of 30 fighting men, besides women and children, there were, a short time ago, two white Indians, though they had recently died and there were none at present. Men from Matoongandi told us that whites occurred in their town as at Alligandi and other San Blas villages. Men from Seebooti told us the same.

At Portogandi, an island about ten miles east of Alligandi, and in communication with the Walla country (which actually extends farther to the westward than indicated by Mr. Marsh) Chief Néllé, a man of high intelligence and a marked thirst for knowledge, who without my asking gave me his family history, including a white relative who had died, told me that in the Walla country there are two small villages in both of which white Indians appear and reside as they do in the coastal villages, and that there are no villages composed solely of white Indians in the mountains. At Portogandi we saw three visiting Walla men. All were brown. The five villages mentioned, the three in constant communication with Alligandi, and the two Walla villages, are, in all probability, and certainly as far as could be ascertained, the only villages in the region designated by Mr. Marsh as the white Indian country.

There seems to be every reason to believe that the report of the existence of settlements of white Indians or of a white Indian country in Darien, as previously described, is untrue; that in the mountain villages, which are in constant communication with the coastal villages, white Indians occur and are treated as elsewhere in the region; that when the white Indians were looked down upon by the browns as undesirables they were killed and buried in infancy; that exiling of the whites does not and, in all probability, never did exist, thus eliminating the raison d'etre of the reported existence of a white Indian country. It is then clear that the white Indians of the San Blas and Darien do not live in isolation as a distinct group.

HOW NUMEROUS ARE THE WHITE INDIANS?

With the banishing of the rumor of white Indian settlements Mr. Marsh's estimate of the existence of one thousand white Indians in the San Blas and Darien must be reduced considerably. As already indicated white Indians are actually found in every town of a population of more than 300 persons on the San Blas coast, and apparently in Darien as well.

Table 1, based on actual observations in the cases of some towns, and on reported numbers in others, forms a comparatively accurate census of the white Indians of the region; the total population, according to Sr. Mojica, Intendente of San Blas, being 19,000 in 1921 and now estimated by him as between 20,000 and 25,000.

TABLE 1.

Town	Estimated population	No. of whites	% of whites
Alligandi	1250	12	1.0 ±
Portogandi	1000	5	0.5 ±
Nagana	1200	8	0.75±
Quede	200	3	1.33±
Tupil	250	2	0.8 ±
Playon Chico	300	2	0.75±
Chucumbale	400	1	0.25±
Banana	500	6[1]	1.0 ±
Navagandi	1000	8*	0.8 ±
Carti	5000	30[1]	0.66±
Sasardi	1500	10*	0.75±
Perro	50	1*	2.0 ±
Ticantici	150	2*	1.75±
Tigre	150	2*	1.75±
Cidra	2000	8*	0.4 ±
Narrgandi	150	2†	1.25±
Misc.	5000	35*	0.7 ±
Entire San Blas	20,100	138	0.69±

Explanation of table.

The number of White Indians given, not followed by an asterisk etc., is in accordance with actual personal observation.

[1]Some of this number seen by me, rest reported.

*Number given according to report of Indians or estimate.

†Recently deceased.

It is obvious that the proportion of white Indians occurring among the San Blas and Darien people, the Tuli Indians, is far in excess of that usually considered as the normal proportion of albinoes to normals, viz. 1:10,000, the white Indians in question being from 50 to 100 times as numerous as would be expected, forming about 0.7% of the total population. The relatively high percentage of whites in the population is even more unusual in view of the following facts; white Indian men are forbidden marriage altogether. White women may marry brown men, but for one reason or another, no doubt mainly because the

brown women are far more attractive than the white, this is very rare. In spite of constant efforts to secure evidence of such matings I have heard of but two cases of a brown man marrying a white Indian woman. 1. Magerite's mother's mother was white. A full account of the results of this mating is given on page 40. 2. A brown man of Tigri was reported to have married a white Indian woman, and upon her decease to have married another white Indian woman. Both women are dead at the present time. Four children, said to be the total number of offspring from the two unions, are reported to have been brown. More definite information could not be obtained. It was further reported to me that a white Indian man of the Walla country married a brown Indian woman. The number or color of the resulting offspring, if there were any, was not known. While too much weight should not be given to either of the last two reports, they show how rare in a population of some 20,000 Indians are matings of this kind. The cases cited are all that were known from Carti to Portogandi within the memory of the oldest inhabitants.

These findings seriously upset the original method of procedure as outlined by the Committee which was, assuming that the white Indians were really RR (homozygous recessive in respect to a single gene governing the differential characteristics of the whites) as Mr. Marsh's data seemed to indicate, to obtain as many family histories as possible in respect to the following types of matings:

albino x albino (RR) x (RR)
albino x dominant (RR) x DR)
albino x dominant duplex (RR) x (DD)
(DR) x (DR)
(DR) x (DD)
(DD) x (DD)

Of these groups of matings (whether or not the white Indians represent an RR condition) it was impossible for me to obtain details concerning the first class, viz., white x white, as a white Indian is never allowed to marry a white Indian. This law holds for all of the San Blas country and for the five towns in the region reported to have been the white Indian country. Every Indian who was asked whether or not white Indians are allowed to marry white Indians, or whether they ever did marry in spite of restrictions to the contrary, answered both questions in the negative. Certainly my own observations confirmed this.

Of the second and third groups of matings, as originally outlined, viz., white x hybrid brown, and white x homozygous brown mention has

already been made. As for the possibility that such matings might occur outside of the bonds of matrimony no one who is well acquainted with the Indians in question could believe, that any such matings could be other than extremely few. Whatever may be the shortcomings of these Indians when left to themselves, sexual promiscuity, or even limited sexual intercourse among others than husbands and wives seems not to occur among the self governed Indians of the San Blas, the Walla or the people of the described headwaters of the Bayano.

From the foregoing it is immediately obvious that the problem of ascertaining the method of inheritance of the striking characteristics: skin color, eye color and hair color, differentiating white Indians from brown Indians is far more complex than originally conceived. With one exception, only matings in which browns of one shade or another were concerned were available for study.

METHOD OF PROCEDURE

As a result of past experience, Mr. Marsh chose Alligandi as the expedition's base. This turned out to be a most fortunate choice, for Alligandi offers many advantages. It is still free from Panaman control, and until our arrival, no foreigner had been permitted to remain on the island after sundown. This was only one method employed by the Indians to prevent racial interbreeding. The Indians maintained that no foreign blood had ever been introduced into their midst, and certainly our own observations upheld this assertion. Alligandi itself is a fairly large town, there being about 1250 persons resident there, and by consequence the number of white Indian inhabitants (12) is relatively large. Due to Mr. Marsh's previous contact with the people of this town, and the fact that two of the Indians taken by him to North America, and but recently returned, were natives of the village, and due to his avowed desire to help the Indians in their ardent wish to remain racially pure in spite of the advancing Panaman hybrid police, we were welcomed to the island and given a house in which to live.

In the household in whose house we lived there were three whites. Our immediate contact with both whites and browns and the friendly attitude of the chiefs inspired confidence in all of the inhabitants of the island, greatly facilitating my work. Furthermore, Alligandi, as the political center of a strong combination of Indian villages, was the meeting place of congresses of representatives from many of the Indian towns on the coast and in the interior. From these friendly visiting representatives further information could be obtained. Finally we found an excellent interpreter who had been abroad 26 years, had

attended school as a boy and young man in Panama, the United States and England, and thoroughly understood our terms of family relationships. Though the Indians consider first cousins brothers and sisters, and though uncles are often called fathers it was comparatively easy to make our man understand the importance of designating uncles as mother's brothers or father's brothers, and of differentiating between brothers and sisters and first cousins, and further to ascertain in what category of first cousins those in question belonged, whether father's sister's child or father's brother's child, etc. The fact that this man had been away for so many years and was originally a native of Playon Chico was a further advantage, in that he could not in any case presume to rely upon his own knowledge, but was forced to inquire in each case, from members of the family being studied, the relationship existing between various individuals. In this connection a method was agreed upon by us whereby all misunderstanding would be eliminated in respect to existing family relationships. We did not ask a woman how many brothers and sisters she had, but how many children her mother had; not how many brothers and sisters her father had, but how many children her mother's husband's mother had; and by other similar means arrived at obtaining accurate family relationships as we understand them.

During our residence at Alligandi I had numerous opportunities of checking information obtained. This was done in every practicable way, and showed such consistency of results that I am thoroughly convinced that the family histories obtained are highly accurate. An example of this may be interesting. The day on which we moved into our house we were visited by the man of the house; the husband, brother in law, son in law, father, father in law, and grandfather of the various members of the household. With the aid of the interpreter I obtained from him the family history of his household. This I had excellent opportunities for checking, for the members of the household were in our house almost continuously, and we came to know them all personally. Furthermore I obtained the family history of collateral lines in the village and the only discrepancy that I ever found in his original statement was the omission of one individual, a sister of his who was light brown in color, and who had died. Either from forgetfulness or because he thought then that I might not be interested in the dead, he failed to mention this member of his family the first day. When I subsequently learned of her and spoke to him about her there was no sign of his having tried to conceal her previous existence from

me. He quite freely gave me the history of the offspring of her line, which in turn I found checked absolutely with that already obtained from other sources. This experience taught me to enquire specifically concerning the dead in obtaining family histories in this region. The response to questions in all cases was so apparently true that, save for families in which all members of the older generation had died and the younger generation could not give information concerning members who may have died before their memory or birth, and save for possible cases in which whites were killed in infancy, and it was desired to keep the fact a secret, I am convinced that the family histories obtained are essentially complete and true. I made every effort to remove the latter possible discrepancy, namely omissions of white children killed in infancy, by frequent confidential remarks to the interpreter that for my purposes a dead person, accurately described, was almost as valuable as a living person, and that in order to obtain accurate information I must know of the dead as well as the living. (Such asides constitute one of the surest methods of dispensing convincing information in an Indian village.)

A final advantage, common to all towns of the region which are not yet under Panaman control, is that all of the female members of all living generations of a family, together with their husbands and children, live in the same house.

Women hold a high position in Tuli Indian society, being considered the foundation of the family, and consequently, tribal life. When a young man is married he cannot be said to "take a wife" for the girl "takes the husband," though not without his consent and that of his family. Upon marriage the young man leaves his mother's house and goes to live in his wife's family's household. This holds true for the husbands of all of the daughters of a household, the grandaughters, and even the great grandaughters, in case there are any with husbands. Thus an Indian household, fortunately for a student of human genetics, contains several related families, living under the same roof. Furthermore, as a rule, the male members of the line marry within the village so that they too may be found without too much difficulty. In fact in Alligandi I found that, save for recent arrivals, refugees from Panaman advance in neighboring villages, all of the Indians on the island were more or less closely related. The importance of this in any genetical study is obvious.

Resumé

The White Indians obviously express a form of albinism which has been termed imperfect or partial albinism by Geoffroy Saint Hilaire,

Pearson and others. These terms signify that either the skin, hair or eyes, any two or all three may fail to express the full albinotic condition, but that one or more are, partially at least, relatively free from pigment.

Such a condition actually applies to the Indians in question. Many, if not all, of the White Indian males have frecklelike copper colored pigment spots of varying size, location and number, which evince an imperfect condition of albinism in the skin. Again the hair is not necessarily devoid of pigment, but in some cases shows traces of brown and in other cases is clearly auburn. Finally the iris is hazel (blue with brown spots), or dark blue, or dark violet. These observations clearly establish the fact that, if any classification of different degrees of albinism is valuable, as no doubt it is, the White Indians of Darien and the San Blas must be considered imperfect or partial albinos.

This contention, as opposed to the classification of these Indians as persons exhibiting idiopathic leucoderma, is supported by the fact that the condition obviously has a genetic basis, and that it is not the result of progressive development but is apparent at birth. Indeed its hereditary nature is demonstrated clearly in the hundred or more matings, the history of which I obtained during my residence in San Blas. If idiopathic leucoderma be considered as an inherited trait, then the terms imperfect and partial albinism and idiopathic leucoderma obviously approach a synonymous significance.

The origin of the condition expressed in the White Indians would seem to be most satisfactorily placed in the mutation theory. I saw no evidence of their origin being traceable to previous miscegenation with Caucasians.

The White Indians appear frequently from matings of brown San Blas Indians, resident on the islands just off the mainland, and on the mainland itself. Indeed this is the principal source of White Indians in the region, as whites are not permitted to mate with whites, and browns only very rarely mate with whites.

Do the White Indians form a race? If for the existence of a race one demands geographical segregation and permanency through the demonstrated production of likes by likes the White Indians can not be said to form a race, for they neither occur by themselves in segregated geographical areas nor are they permitted to reproduce their kind. But if, in a definition of race, one includes any group exhibiting strikingly differential characteristics which are insured of permanency by virtue of possessing a genetical basis, then the White Indians of the San Blas may be said to form at present a race which, due to artificial restrictions, is de-

pendent for its continued appearance upon another race, carrying factors for the former's inherited differential characteristics in its germplasm. It is obvious that whatever definition is applied the difference is not qualitative but rather quantitative; the qualitative basis, genetical nature of differential characteristics, being present in either case. Whether or not it is admitted that the White Indians now form a distinct race there can be no question that, at least, they hold potentialities for race production.

Actually, it may be repeated, the whites do not occur by themselves in a segregated geographical area but are to be found in varying numbers in practically all the "brown" villages of the region, where they appear, from time to time, from matings of recessive carrying browns with recessive carrying browns. The whites form about 0.7 per cent of the total population: an exceedingly high proportion for any form of albinism. This high proportion I attribute to the fact that intense inbreeding has occurred for some time in the Indian villages. Thus conditions are highly favorable for the frequent expression of any recessive traits occurring in the strain. Since all known forms of albinism are apparently recessive to the normal condition, and as albinism, like all recessive traits, occurs more frequently in consanguineous marriages than in the population at large, the observed high proportion of whites among the San Blas Indians is not astounding, in view of the constant inbreeding which occurs.

The exact method of inheritance functioning in the present instance is not yet established. The condition is apparently recessive to the normal, but it is not clear whether it is due primarily to the action of a single gene, in its interrelation to the whole chromosomal content, or whether the genetic composition of the whites differs in more than one gene from that of the normal San Blas Indians.

Contrary to previous reports the white Indians seem, in general, to be smaller than the brown Indians. Among the males for whom data are at hand this holds in respect to stature, height to presternal notch, to crest of ileum, sitting height, hip circumference, span, forearm length, and total facial length (nasion to gnathion). The whites give longer measurements than the browns in respect to upper arm length, difference 4 mm.; calf cicrumference, difference 2 mm.; head length, difference 4 mm.; bizygomatic breadth, difference 2 mm.; while similar measurements are obtained for the two classes in respect to foot width and head breadth. The whites have a greater relative span than the browns, and a greater bizygomatic breadth in relation to head breadth.

GENETICAL DATA

Family histories and individual measurements as taken are reproduced in the following charts and tables.

Table 2 gives the massed data obtained from family histories in respect to the several types of matings B x B (brown x brown), BxLB or VLB (brown x light brown), B x W (brown x white) and LB x LB or VLB (light brown x light brown or very light brown). If it is assumed that B represents the homozygous dominant condition, LB or VLB the hybrid or heterozygous, and W the homozygous recessive condition, this massing of the data gives some indication of the method of inheritance involved in the condition represented by white Indians.

While any statement of genetypical composition based on phenotypical appearance in humans may be said to be indefinite, and while any classification based on such a variable characteristic as color of skin obviously incurs the danger of the inclusion of one group within another, due to the difficulty of establishing a definite line of differentiation, still this method has been widely used in the study of human inheritance with marked success. In the present instance, though in individual cases it may be practically impossible to state whether a

TABLE 2.

Matings	No. of matings	No. of offspring	W	LB or VLB	B	% W
Pop. at Large	—	20,000*	138*	—	—	0.69*
Family Histories	—	563	47	399	117	——
B x B	9	38	0	11	27	0.00
B x LB or VLB	21	69	1	46	22	1.46
B x W	1	2	0	2	0	0.00
LB x LB or VLB	68	309	44	232	33	14.24
Unknown	—	145	2	108	35	——

*From table 1.

person belongs to the brown or to the light brown class, in by far the majority of cases the classification is simple and no doubt corresponds, with a high degree of consistency, to the actual genetypical state. The white (homozygous recessive) class is easily distinguishable from either of the others, and it is believed that the other classifications are comparatively accurate.

With the foregoing qualifications in mind it is noted that the previous statement that the condition expressed by the white Indians is apparently recessive to the normal is substantiated by the data at hand. Thus no whites appear among the 38 offspring from matings of B x B. In the B x LB or VLB of 69 offspring 1 is given as white. This exception may be due to the possible infrequent discrepancy of classification noted above. The father of the individual in question was reported to

be brown though he probably is a dark light-brown. The offspring produced by the B x W mating are light brown as would be expected. Of the 309 individuals which resulted from LB x LB or VLB (hybrid by hybrid) matings, 44 are white, 232 LB or VLB and 33 are B. This further substantiates the theory that the partial albinotic condition is recessive to the normal condition.

It is impossible to state definitely whether only one factor or more than one factor is the determiner of the differential characteristics observed. If but one factor were involved one would expect to find among the 309 offspring from hybrid by hybrid matings 77 whites, 155 LB or VLB and 77 B. The observed ratio is 44 W, 232 LB or VLB and 33 B. It might be possible that some of the browns are classed as light browns, upon which assumption the LB and B classes could be hypothetically corrected to approach expectancy. On the other hand the white class, which is also less than expectancy, if but one factor is involved, cannot draw recruits from the light brown class, as the differential characteristics are clear cut and free from possible confusion. It might be held that the white class is artificially small, due to desire on the part of the Indians to withold information concerning whites, but I doubt if such is applicable in the present instance, at least to an extent sufficient to overcome the observed difference between actual data and expectation. The final possibility is that a few of the matings classed as LB x LB may actually be matings of B x LB in which case the number of offspring occurring in the LB x LB or VLB group of matings as given would be reduced with a concurrent reduction in the number of whites to be expected. On the other hand the data would permit an interpretation based on the presence of more than one determining factor, the factors being closely but not absolutely linked, thus giving as a result of infrequent crossing over, the observed ratio (1 white to 6 LB or B instead of 1 white to 3 LB or B as would be expected if but one factor were involved). It is obvious that the data at hand do not definitely preclude either possibility, and that the conclusions drawn from them must be limited to the following:

"The condition (white Indian) is apparently recessive to the normal, but it is not clear whether it is due primarily to the action of a single gene, in its interrelation to the whole chromosomal content, or whether the genetic composition of the whites differs in more than one gene from that of the normal San Blas Indians."[9]

Harris, R. G. The White Indians of Darien. *Science*, 1925, LXI.

Family Histories

The following symbols have been employed:

brown (B), light brown (LB), very light brown (VLB)
white (W), male. female, sex unknown.

The Roman numerals at the left refer to generations; the arabic numbers at the lower right of the symbols refer to the number of the individual in the generation; and the arabic numerals at the upper right of the symbols refer to individual anthropometrical data which may be found under that number in Table 16.

FAMILY 1. (OLO)

See chart 1: *Sister to I 6 family 2, and to I 4 family 3.

*Olo is the older of the white boys taken by Mr. Marsh to the United States. We lived in this family's main house during our stay of about one month in Alligandi. In this family from matings of LB x LB it is seen that of a total of 33 resulting offspring 3 are white, 27 LB or VLB and 3 B. Such a ratio would indicate that the explanation of the occurrence of white Indians and light brown Indians should not be based on the theory of a simple Mendelian gene mutation, in which case the expected ratio would be among thirty-three individuals approximately 8 whites, 17 light browns and 8 browns.

The skin color of 17 individuals, members of the immediate family is as follows:

Table 3.*

Indiv.		% Black	% Red	% Yellow	% White	Hair	Eyes
I	4	15.0	37.5	36.5	11.0	black	brown
II	9	25.0	31.0	17.5	26.5	"	dk brown
II	10	30.0	33.5	26.0	10.5	"	" "
II	11	7.5	16.5	23.5	52.5	flaxen	hazel
II	15	5.5	18.0	7.0	69.5	"	hazel
II	12	27.0	13.5	11.5	48.0	black	dk brown
III	5	13.0	43.5	32.5	11.0	"	" "
III	6	17.0	44.5	31.5	7.0	"	" "
III	8	14.0	43.5	32.0	10.5	"	med "
III	7	5.5	29.5	46.5	18.5	"	" "
III	9	13.0	42.0	34.5	10.5	brown & black	dk "
III	10	20.0	32.5	36.5	11.0	" " "	" "
III	11	15.0	37.0	36.5	11.5	black	med "
III	12	13.5	31.5	39.0	16.0	dk brown	dk "
IV	1	33.5	22.0	14.5	30.0	black	" "
IV	2	5.5	18.5	6.5	69.5	very lt flaxen	dk blue
IV	3	13.5	42.5	34.0	10.0	brown	dk brown

*See technique of Color Determination, p. 47.

A variation in hair color from brown to black, and in eye color from medium brown to dark brown is also noted among the light browns of this family.

Of the three whites, two, Olo and his sister, have flaxen hair and hazel eyes, the most frequent combination observed among the whites, and considered by persons acquainted with the region as "typical." It is to be noted, however, that the third white, a girl of six or seven (IV 2), has dark blue or violet eyes.

FAMILY 2

This family is related to Family 1 and Family 3: *Sister of I, 4, family 1.

It is noted that the five LB x LB or VLB matings produced a total of 30 offspring—of these 6 are white, 23 are LB and 1 is B. The expectation is approximately 7 white, 16 LB and 7 B. In this family if the LB and B are grouped together, the actual numbers observed, 6 white and 24 brown (LB or B) very closely approaches the ratio to be expected (7 white and 23 LB or B) if a one gene mutation is involved.

FAMILY 3

This family is related to family 1 and 2: *Sister of I, 4, family 1, and of I, 6, family 2.

The children of I, 4 of this family are first cousins of Olo and his brothers and sisters, II, 10, 11, 12, 14, 15, and 16 of family 1. An interesting case of twinning occurs in both 3rd and 4th generations of this family. If in this instance the trait is inherited it seems to have been passed on from mother to daughter. Twinning is rare apparently among these Indians while I heard of but one case of triplets.

It is noted that of 22 offspring from matings of LB x LB or VLB, 5 were white, 15 were LB or VLB and 2 were B. If a single gene recessive were concerned and LB represented the hybrid condition the expectation for such matings, 22 offspring, would be about 5 whites, 12 LB and 5 browns. The massed results compare fairly closely with the expectation. An analysis of the individual matings gives the following results: a LB x LB mating in generation I produced 8 offspring in generation II; of these 4 are white and 4 VLB. The expectation according to the theory mentioned would be 2 whites, 4 LB and 2 browns. One of the VLB in this generation mating with a LB gives in generation III the following offspring, 1 white, 7 LB and VLB and 2 B; expectation would be approximately 2 white, 5 LB and 3 browns. One of the VLB in this generation when mated to a LB has 4 offspring all LB. The expectation is 1 white, 2 LB and 1 brown.

On the other hand in the first generation of the male side of the house a SLB ♂ (I, 1) when mated with a B ♀ (I, 2) produces 4 offspring, 3 brown and 1 LB. The expectation would be 4 brown. One of these generation II browns marries a brown. The six resulting children are brown. Another B of the same generation marries a SLB; the three resulting offspring are VLB. In the third generation a VLB ♀ marries a B ♂, the single child is LB.

The five whites reported in this family are all dead, but were said to have been of the type of II, 11 and 15, family 1, i.e., with hazel eyes and flaxen hair.

FAMILY 4 (MAG)

Maguerite: The white girl taken to the United States by Mr Marsh.

This family is particularly interesting as it contains several types of matings, including the only authentic case I obtained concerning a B x W mating. It is to be noted that of two offspring resulting from this union one is LB and the other VLB. These in turn married; the first marrying a LB man by whom she had 7 children, 5 white and 2 LB. The second VLB married two brothers in succession, one LB, the other reported B, probably LB; from each of these matings she bore two boys, 1 white and 1 brown in each case. Thus of the original B x W mating there occurred in the F_2 generation 7 whites, 2 LB and 2 B. It will be seen that the first husband of II, 5 also married a LB woman of unknown parentage by whom he had 2 LB children. A union of B (II 1) x LB (II 2) is noted with three resulting offspring, all LB.

FAMILY 5 (CHEP)

*Cheepo. II, 9 has 7 children, none white, all alive; II, 10 has 8 children, none white, all alive.

Of the three LB x LB matings appearing in this family history the following resulting offspring are noted (1) 6 children, all LB, (2) 6 children, all LB, (3) 8 children, 4 white, 4 brown. Of the total 20 children produced 4 are white, 12 LB and 4 B. The expectation based on the theory of a single gene mutation would be 5 white and 15 LB and B.

Charts for families 1 to 16 inclusive may be found on pages 60 to 63.

Anthropometrical Data

Method—A wooden anthropometer with sliding cross bars was furnished me by Prof. Neumann, Rector of the Instituto Nacional of Panama. This anthropometer was graduated according to the metric system and was used for all of the major height measurements, and span.

Captain Perry of the U. S. A. M. C., stationed in the Canal Zone, kindly loaned me a pelvimeter, which was used in head, facial and in certain other length and breadth measurements. Tapes were used in measuring girths and circumferences, and the skin color was measured with the aid of the Pupil's Color Top, Number 8109, manufactured by the Milton Bradley Company of Springfield, Mass. Reproductions in two dimensions were made of the foot. The foot measurements were taken from these outline tracings. Hair samples were taken. Save for chest girth and hip circumference all measurements were taken in contact with the skin or in the presence of a negligible amount of clothing. The chest girth was taken over an outer shirt or blouse; there was no under garment. The hip circumference was also taken over an outer garment. As the tape was pulled tightly in both cases no change in the measurements as taken has been made. Forty-six persons were measured, 14 normal males, 26 normal females, 5 white males and 1 white female. All were adults.

Method of Taking Measurements

1. Stature: the subject, barefooted, stood on the wooden base of the anthropometer. The height of the vertex was taken with the aid of the sliding cross bar.
2. Supra sternal notch: the technique was similar to that employed in 1. The height of the deepest point in the hollow was recorded.
3. To crest of ileum: the technique employed was similar to that of 1, the anatomical landmark here being the crest of the ileum.
4. Sitting height: the subject sat on the wooden base of the anthropometer, about 3 cm. high; the legs were relatively straight.
5. Biacromial breadth: the maximum distance between the two acromial points was measured with the pelvimeter.
6. Bitrochanteric breadth: the maximum distance between the external surfaces of the great trochanters was taken. Pressure was applied to the pelvimeter in making this measurement. The subject was erect as in 1.
7. Chest circumference: the measurement was taken in the horizontal plane at the height of the nipples. The subject was erect, chest "at rest."
8. Circumference of upper arm: the maximum circumference of the upper arm, muscles relaxed, was taken.
9. Circumference of the forearm: the maximum circumference of the fore-arm, elbow slightly flexed, was taken.
10. Circumference of the hip: this was measured in the horizontal plane at the height of the external surfaces of the great trochanters.
11. Circumference of the calf: the maximum circumference of the calf was taken; subject erect.
12. Span: the subject was placed against a wall. The distance between the tips of the middle fingers of the two hands was measured with the aid of the anthropometer.
13. Upper arm length: the distance between the proximal and distal ends of the humerus was taken.
14. Fore-arm length: the distance between the head of the radius and the styloid process was taken.
15. Foot length: this is described in the preceding paragraph.
16. Foot breadth: this is described in the preceding paragraph.
17. Head length: the maximum head length, measured with the pelvimeter, was recorded.

18. Head breadth: the maximum head breadth, measured with the pelvimeter, was recorded.
19. Bizygomatic breadth: the maximum distance between the external surfaces of the zygomatic arches was measured with a pelvimeter.
20. Nasion to chin: the measurement was taken with a pelvimeter.
21. Ear length: the maximum length of the external ear was taken.
22. Nose height: the maximum distance from the nasion to the posterior tip of the nasal cartilage was measured.

STATURE

The Indians of the San Blas coast seem to be the shortest Indians as yet reported. According to Martin the shortest American natives previously reported are the Polar Eskimos for whom Steensby gives 157.0 cm. for the mean stature of males and 145.4 cm. for the females. Deniker gives the stature of Carribean males from Guiana and Venezuela as 157.2. In fact the San Blas Indians appear to be among the shortest groups in the world, approaching the Andamans of India (males 148.2, females 140.2, Martin), and the Pygmies (Mawambi males 140.8, females 135.6, Czekanowski). Table 4 gives other comparative data obtained by various authors.

TABLE 4. STATURE.

Locality or group	Num.	Average male cm.	Average female cm.	Reference
San Blas (N)*	14 ♂, 26 ♀	149.9	140.4	
San Blas (W)†	5 ♂, 1 ♀	145.7	144.9	
Quichua (Pure)		158.3	142.6	Ferris, 1916.
Laborador Eskimo		157.5	148.0	Boas
Japanese		159.3	147.2	Miwa
Laplander (Norwegian)		152.3	145.0	Mantegazza & Soummier
Chiriguan		163.4	151.1	Lehmann-Nitsche
Hopi Pueblos		163.8	150.7	Hrdlička
Maricopa		174.9	160.4	Hrdlička

*Normal.
†Partial albinoes.

Data relative to the height to the suprasternal notch and to the crest of the ileum may be found in Table 15. The partial albinotic males are smaller than the normal males in respect to stature, height to suprasternal notch and to crest of ileum.

SITTING HEIGHT

As would be expected, in view of the extremely short stature of the San Blas Indians the absolute sitting height is also very small in comparison with other groups. The relative sitting height shows that the legs are relatively long giving a ratio similar to the Trumai; among American natives. Table 5 gives the findings concerning the San Blas together with data for other groups for comparison. The partial albinotic males have a smaller absolute sitting height than the normal males. The relative sitting height for the two groups is practically the same.

TABLE 5. SITTING HEIGHT.

Locality or group	Num.	Average male cm.	Average female cm.	Reference
San Blas (N).......	14♂, 26♀	75.1	72.1	
San Blas (W)......	5♂, 1♀	72.9	73.7	
Quichuas..........	124♂, 1♀	83.6	79.4	Ferris, 1916
Brewarrina (N.S.W.)	6♂, 7♀	83.1	75.2	Davenport, 1925

RELATIVE SITTING HEIGHT

	Average male %	Average female %	Reference
San Blas (N)....................	50.0	51.3	
San Blas (W)....................	50.1	50.8	
Quichuas........................	51.6	55.6	Ferris, 1916
Brewarrina (N. S. W.)...........	49.8	49.4	Davenport
Eskimo..........................	51.4	53.2	Martin
Shoshoni........................	52.2	52.7	Martin
Trumai..........................	50.6	51.1	Martin

SHOULDER WIDTH

The absolute biacromial breadth is small in comparison to that of other groups, due to the general smallness of the San Blas Indians. The biacromial breadth relative to stature, however, shows that this group is comparatively broad shouldered. See Table 6 for comparative data. The partial albinotic males have a smaller absolute biacromial breadth than normal males. The relative shoulder width of the partial albinoes is slightly less than that of normal San Blas Indians.

TABLE 6. BIACROMIAL BREADTH.

Locality or group	Num.	Average male cm.	Average female cm.	Reference
San Blas (N).........	14♂, 26♀	36.4	33.0	
San Blas (W).........	5♂, 1♀	36.0	32.5	
Quichuas.............	124♂	38.1	——	Ferris, 1916
Eskimos..............	10♂	37.9	——	Duckworth

RELATIVE BIACROMIAL BREADTH

Locality or group	Average male %	Average female %	Reference
San Blas (N)....................	24.2	23.3	
San Blas (W)....................	23.6	22.4	
Quichuas........................	24.0	——	Ferris, 1916
Eskimo..........................	24.3	22.7	Martin
Shoshoni........................	23.2	22.6	"
Japanese........................	23.5	23.2	"
Bushmen.........................	20.0	20.0	"
Belgians........................	23.4	22.0	"

GIRTH OF CHEST, AT REST

While the absolute chest girth of the San Blas Indians is comparatively small (Table 7), it is noted that in relation to stature this group is among the most "thick-set" groups of the world. The chest girth of females, as given, is of little comparative value as the measurement includes the breasts at the height of the nipples. Apparently the partial albinotic males are less "thick-set" than normal males.

TABLE 7. CHEST GIRTH.

Locality or group	Num.	Average male cm.	Average female cm.	Reference
San Blas (N)..........	14♂, 26♀	88.4	94.5*	
San Blas (W)..........	5♂, 1♀	84.8	84.5	
Central South Australia..	20♂, 10♀	90.3	82.2	Spencer and Gillen, 1899

RELATIVE CHEST GIRTH

	Average male %	Average female %	Reference
San Blas (N)....................	58.8	67.3*	
San Blas (W)....................	58.2	58.3	
Yaghan (Tierra del Fuego)........	58.7	——	Martin
Japanese........................	50.8	48.7	"
M'Balsa.........................	50.3	46.0	"
Snaheli (Brit. E. Africa)...........	59.1	——	"
Central South Australia...........	51.7	52.4	Spencer and Gillen, 1899

*See text

HIP BREADTH

Table 8 gives the absolute bitrochanteric breadth, and this breadth relative to stature and to biacromial breadth. It is noted from the comparative data contained therein that the San Blas Indians are relatively broad hipped both in respect to stature and to shoulder breadth. According to all three classifications the partial albinotic males are smaller across the hips than normal males.

The data in respect to hip circumference gives similar results. See Table 15.

TABLE 8. BITROCHANTERIC BREADTH.

Locality or group	Num.	Average male cm.	Average female cm.	Reference
San Blas (N).........	14♂, 26♀	29.3	29.2	
San Blas (W).........	5♂, 1♀	27.9	32.5	
Quichuas.............	124♂	30.4	——	Ferris, 1916
Japanese.............	500♀	——	27.8	Ogata

RELATIVE BITROCHANTERIC BREADTH

Locality or group	Average male %	Average female %	Reference
San Blas (N)....................	19.4	20.8	
San Blas (W)....................	19.1	22.4	
Quichuas........................	19.2	——	Ferris, 1916
Japanese........................	18.6	19.8	Koganei
Aino............................	18.7	20.4	"
Colorado Indian..................	18.3	20.0	Martin
M'Balsa.........................	16.7	17.6	"

BITROCHANTERIC BREADTH ÷ BIACROMIAL BREADTH

Locality or group	Average male %	Average female %	Reference
San Blas (N)....................	80.4	88.6	
San Blas (W)....................	77.5	100.0	
Quichuas........................	79.3	——	Ferris, 1916
Chinese.........................	82.3	——	Martin
M'Balsa.........................	75.1	79.9	"
Parisians.......................	83.0	91.8	"

SPAN

Table 9 gives my measurements and comparative data concerning absolute and relative span. The relative span is extremely high, being

even higher for partial albinotic males than for normals. So far as I know this is the highest relative span recorded for any group. It is approached by the Dschagga of Africa (Martin) males, 108.6. In this group the females, 106.4, have a higher relative span than that which I found among the San Blas women, 105.9. Other male groups with high relative span include, according to Martin, the Irokes, 108.9; the Arup D-New Guinea, 108.8; and the Kadirs, 107.0. The Mawambi-Pygmies have a relative span among the males of 105.2 and of 107.3 among the females.

Data concerning arm length, forearm length, upper arm circumference, greatest; forearm circumference, greatest; and calf circumference, greatest, are given in Table 15.

TABLE 9. SPAN.

Locality or group	Num.	Average male cm.	Average female cm.	Reference
San Blas (N)	14 ♂, 26 ♀	163.7	148.6	
San Blas (W)	5 ♂, 1 ♀	159.8	152.6	
Quichuas	124 ♂	162.0	145.8	Ferris, 1916
Brewarrina (N. S. W.)	6 ♂, 7 ♀	175.0	159.8	Davenport, 1925

RELATIVE SPAN

Locality or group	Average male %	Average female %	Reference
San Blas (N)	109.0	105.9	
San Blas (W)	109.7	105.3	
Quichuas	102.3	102.2	Ferris, 1916
Polar-Eskimo	99.3	97.9	Martin
Aueto	106.1	105.1	"
Numatagmint-Eskimo	103.1	102.4	"
Dschagga (Africa)	108.6	106.4	"
Aino	105.9	104.6	"
Japanese	102.6	100.5	"
Brewarrina (N. S. W.)	105.1	104.5	Davenport, 1925

HEAD LENGTH AND HEAD BREADTH

Table 10 gives data concerning the absolute head length and head breadth and the cephalic index (head breadth ÷ head length). It appears that the white males have slightly longer heads than normal males. This is due primarily to individual No. 2, who has the extremely large head-length measurement for this group of 21.2 cm. This partial albino had an unusually large head, the breadth being 16.8 cm. It is noted that the San Blas Indians, like many American Indians, are markedly brachycephalic.

TABLE 10. HEAD LENGTH, BREADTH.

Locality or group	Average length Male cm.	Average length Female cm.	Average breadth Male cm.	Average breadth Female cm.
San Blas (N)	18.6	17.7	15.8	15.2
San Blas (W)	19.0	18.0	15.8	16.5
Quichuas	18.5	18.5	14.8	14.7
Shoshoni	19.2	18.4	15.3	14.6
Asiatic Eskimo	19.0	18.4	15.3	14.7
Chiriguan	18.4	17.3	14.8	14.1

TABLE 10 (*Continued*)
HEAD BREADTH ÷ HEAD LENGTH

Locality or group	Average male %	Average female %	Reference
San Blas (N)	84.9	86.1	
San Blas (W)	83.4	91.7	
Quichuas	79.9	71.4	Ferris, 1916
Shoshoni	79.5	79.5	Boas
Asiatic Eskimo	80.8	79.7	Bogoras
Chiriguan	80.2	81.4	Lehmann-Nitsche

FACIAL PROPORTIONS

Table 11 contains data concerning the absolute bizygomatic breadth and the total facial height (nasion to chin), as well as the total facial index (nasion-chin ÷ bizygomatic breadth), and the bizygomatic breadth relative to head breadth. It is noted that the San Blas Indians have a comparatively large bizygomatic breadth. The relative face width likewise indicates a relatively broad face. The partial albino males have a relatively broader face than the normal males.

TABLE 11. BIZYGOMATIC BREADTH.

Locality or group	Average male cm.	Average female cm.	Reference
San Blas (N)	14.3	13.7	
San Blas (W)	14.5	13.0	
Quichuas	14.1	13.5	Ferris, 1916
Eskimo	14.2	13.6	Duckworth
Japanese	14.1	——	Balz
Navaho	14.7	13.8	Hrdlička
Chinese	14.4	——	Koganei

NASION-CHIN.

Locality or group	Average male %	Average female %	Reference
San Blas (N)	11.3	10.8	
San Blas (W)	10.7	12.0	
Quichuas	11.6	11.2	Ferris, 1916
Eskimo	12.7	11.7	Duckworth
Chiriguan Navah	12.3	11.1	Lehmann-Nitsche
Navaho	12.0	11.3	Hrdlička
Chinese	12.5	——	Koganei

NASION-CHIN ÷ BIZYGOMATIC BREADTH.

Locality or group	Average male %	Average female %	Reference
San Blas (N)	79.1	78.2	
San Blas (W)	74.7	92.3	
Quichuas	82.9	82.9	Ferris, 1916
Shoshoni	80.5	79.2	Boas
Chiriguan	87.3	86.0	Lehmann-Nitsche
Asiatic Eskimo	88.8	89.7	Bogoras
Chinese	87.0	——	Koganei

BIZYGOMATIC BREADTH ÷ MAX. HEAD WIDTH.

Locality or group	Num.	Average male %	Average female %	Reference
San Blas (N)	14♂, 26♀	91.0	90.3	
San Blas (W)	5♂, 1♀	92.3	78.8	
Quichuas	124♂, 1♀	94.2	91.8	Ferris, 1916
Japanese		94.6	——	Adachi
Chinese		95.1	——	Reicher
Eskimo (Numatagmint)		100.8	——	Boas
Athapascan (Tahltan)		94.8	——	Boas
Australian		100.6	93.8	Brackebusch

FOOT LENGTH

The foot length relative to stature is similar to that of other Indians and to that of the Chinese. See Table 12.

TABLE 12. FOOT LENGTH.

Locality or group	Average male cm.	Average female cm.
San Blas (N)	23.0	21.0
San Blas (W)	22.1	21.7
Quichuas	24.4	21.2

RELATIVE FOOT LENGTH

Locality or group	Average male %	Average female %	Reference
San Blas (N)	15.3	14.9	
San Blas (W)	15.1	14.7	
Quichuas	15.1	14.9	Ferris, 1916
Colorado Indians	15.0	14.5	Martin
Brazilian Indians	15.2	14.8	"
Chinese	15.1	15.2	"

Technique of Color Determination. In order that the present results may be compared with previous color determinations by Davenport, Todd, Van Gorder and others, the Pupil's Color Top, Number 8109, manufactured by the Milton Bradley Co., of Springfield, Massachusetts, was used. The percentages given in the tables apply to the color disks supplied with the tops. These colors in terms of components based on Ridgway's book of standards and nomenclature are as follows:

Black is standard; white is standard; yellow is Ridgway's lemon yellow, pure spectrum yellow. There are two reds in the Bradley Color Top. One, called "red" by Bradley, as has been noted by Todd and Van Gorder, is between Ridgway's carmine (i) and ox blood red (k) and is considered by these writers as (j), being composed of 41% red and 59% black. As a matter of fact, this red of the Bradley Color Top is obviously nearer ox blood (k) than carmine (i). By various color top methods we have found the components to be very approximately 33% spectrum red and 67% black (Ridgway's classification). The other red of the Bradley Color Top is found to be between bitter sweet orange (b) and flame scarlet (full color), approaching more closely the latter than the former and hence cannot be considered as (a). Its value very approximately is 3% white and 97% OR-O. This latter component is found to be composed very approximately of 82% Ridgway's spectrum red and 15% Ridgway's lemon yellow, that is, pure spectrum yellow. Thus there is more spectrum red in this second red color disk "orange" than in that employed by Todd, Davenport and others, "red." Since I found it easier to measure skin color with the "orange" disc than with the "red" disc, perhaps other workers may find it desirable to use this color. Blue is Bradley's blue in Ridgway's classification and represents approximately 72% blue and 28% violet. Violet is between Ridgway's haematoxylin violet (i) and pleroma violet (full color) and represents approximately 69% violet, 5% red and 26% black.

The colors in the tables are recorded according to the color top observations. When so desired, corrections may be made in accordance with the foregoing data.

Measurements of the color of the skin were taken in comparison with the under side of the forearm as this seemed to be the region the most protected from the sun's tanning effect, to which access was easily obtained. The color measurements as given hold for relatively unexposed skin. At the same time it is noteworthy that even this "relatively unexposed" region is actually decidedly tanned, though less so than continually exposed parts. The following color measurements made in respect to parts of one woman's body which had undergone different degrees of exposure is demonstrative of the necessity of measuring similar regions if results valuable for comparison are to be obtained. Fortunately the woman in question had just removed a bead band bracelet, which had probably been worn for many months if not years, and had effectively shielded the underlying skin. This unexposed skin further gives an indication of the amount of color of the Indian's skin which is due to the response to exposure to the sun.

TABLE 14.

	Black %	Red* %	Yellow %	White %
1. Newly exposed skin, forearm	3.0	13.5	33.5	50.0
2. Under side forearm, usual point of measurement, relatively unexposed	27.0	13.5	11.5	48.0
3. Face, frequently protected by red head covering	25.0	44.5	23.5	7.0
4. Exposed skin of same forearm as 1 and 2	44.0	33.0	18.0	5.0

*Bradley's "orange." See discussion of technique of color determination.

It is noted from the data in Table 16, that the skin color of the San Blas Indians who are said to be normal varies from very light brown to a brown which is comparatively dark for relatively little exposed skin. This has already been noted in the presentation of genetical data, and no doubt indicates both different genetical constitution and individual variation

EYE COLOR

Iris color among the brown Indians varies from medium brown to dark brown; and among the partial albinoes from hazel (blue with brown spots) to dark blue and dark violet.

HAIR

The hair is black in color, of fairly coarse texture, and straight among the majority of the brown Indians. In some cases, however, the hair is brown, especially near the distal end; while frequently it is of medium or even fine texture, and very infrequently slightly wavy. The hair of the white Indians ranges in color from flaxen and straw to auburn and very light brown, and is frequently finer in texture than that of the brown Indians.

SKIN TEXTURE

The skin of the partial albinotic Indian is often rough in contrast to the smooth or velvety skin of the brown Indian. As a rule the skin of the partial albinoes does not tan with exposure. It is apparently more susceptible to skin diseases than that of the browns. Many of the white males have frecklelike copper colored pigment spots of varying size, location and number. The Indians told me that such spots never appear upon the female partial albinoes. As far as I could observe this statement seemed to hold.

FIG. 1. Adult partial albino women from Playon Chicos. They are Individuals II, 16 and 17 of Family 11. Both have auburn hair, that of the one on the right being deep auburn.

FIG. 2. Partial albino Indian boy and father from Portigandi. The son has numerous freckle-like pigment spots on his back. Anthropological observations and measurements concerning the father will be found under No. 35 of the Table of Individual Measurements. He is Individual III, 6 of Family 6.

TABLE 15

	Average Male N	Average Male W	Average Female N	Female W (1)	Greatest Male (N)	Least Male (N)	Greatest Female (N)	Least Female (N)
Height total	149.9	145.7	140.4	144.9	158.4	144.4	145.7	131.6
to presternal notch	122.3	119.5	115.8	119.1	129.8	111.9	126.0	106.6
to crest of ileum	87.0	82.5	84.0	85.9	92.2	81.7	89.8	78.7
sitting	75.1	72.9	72.1	73.7	79.2	69.7	76.8	66.5
Biacromial breadth	36.4	36.0	33.0	32.5	40.2	30.6	35.0	31.1
Chest circumference	88.4	84.8	94.5	84.5	92.5	81.5	106.0	81.5
Bitrochanteric breadth	29.3	27.9	29.2	32.5	31.2	28.0	32.0	27.3
Hip circumference	83.0	81.7	87.7	88.6	92.2	77.7	94.0	80.3
Span	163.7	159.8	148.6	152.6	173.0	156.3	158.1	134.1
Upper arm length	28.8	29.2	27.2	31.0	31.6	26.7	29.6	22.6
Forearm length	25.2	24.2	21.7	22.0	27.0	23.2	24.6	18.7
Upper arm circumference	24.7	23.9	23.7	—	27.1	22.8	27.0	20.7
Forearm circumference	24.1	22.8	21.2	20.0	26.0	22.8	29.7	18.2
Calf circumference	29.6	29.8	26.2	—	31.6	26.1	29.2	24.3
Foot length	23.0	22.1	21.0	21.7	24.6	22.1	22.3	19.3
Foot width (greatest)	9.4	9.4	8.6	8.7	10.8	8.6	9.4	7.3
Head length	18.6	19.0	17.7	18.0	19.5	17.5	19.6	16.6
breadth	15.8	15.8	15.2	16.5	16.7	15.0	16.4	14.0
Bizygomatic breadth	14.3	14.5	13.7	13.0	15.5	13.6	15.0	13.0
Nasion-gnathion	11.3	10.7	10.8	12.0	12.1	10.0	11.9	9.6
Indices								
Span÷stature	109.0	109.7	105.9	105.3	113.1	105.2	109.5	101.9
Height sitting÷stature	50.0	50.1	51.3	50.8	52.5	48.3	56.4	47.2
Chest girth÷stature	58.8	58.2	67.3	58.3	62.7	56.4	77.0	59.0
Biacromial breadth÷stature	24.2	23.6	23.3	22.4	40.2	30.6	35.0	31.1
Bitrochanteric breadth÷biacromial breadth	80.4	77.5	88.6	100.0	89.3	73.7	95.3	82.1
Bitrochanteric breadth÷stature	19.4	19.1	20.8	22.4	20.6	18.7	22.4	19.4
Forearm length÷upper arm length	87.4	83.2	80.3	70.9	97.8	76.9	92.9	73.8
Foot length÷stature	15.3	15.1	14.9	14.7	16.4	14.7	15.9	14.1
Head breadth÷head length	84.9	83.4	86.1	91.7	88.6	82.4	94.8	08.6
Bizygomatic breadth÷head breadth	91.0	92.3	90.3	78.8	98.0	88.1	93.6	81.5
Total facial index	79.1	74.7	78.2	92.3	85.1	72.9	85.4	70.2

TABLE 16. INDIVIDUAL MEASUREMENTS AND INDICES

		1	2	3	4	5
1.	Normal San Blas or partial albino	PA	PA	N	N	N
2.	Locality	Alli	Alli	Alli	Alli	Alli
3.	Age in years (approximate)	35–40	30	35	30	25
4.	Sex	F	M	F	F	F
5.	Location on pedigree charts	1, II, 11	2, II, 21		1, III, 6	11, I, 3
6.	Iris color	hazel	hazel	d brown	d brown	d brown
7.	Epicanthus			present	present	present
8.	Hair color	flaxen	fl and lb	black	black	black
9.	Hair texture	silky	medium	coarse	coarse	coarse
10.	Beard	none	sparse	none	none	none
11.	Skin color					
	Black	*4.5	*6.0	*15.0	17.0	*22.5
	Red	16.5	13.5	30.0	44.5	28.0
	Yellow	23.5	16.0	25.0	31.5	33.5
	White	47.5	61.5	15.0	7.0	11.0
12.	Skin texture	rough	rough	velvety	velvety	smooth
13.	Skin humidity	dry	dry	dry	dry	dry
14.	Teeth, general condition	good	good	good	good	good
15.	Height—total	144.9	146.2	144.9	145.0	131.6
16.	To suprasternal notch	119.1	120.6	125.0	126.0	106.6
17.	To crest of ileum	85.9	83.0	81.5	86.5	79.0
18.	Sitting	73.7	74.4	76.8	74.7	68.9
19.	Biacromial breadth	32.5	36.2	33.5	34.0	31.3
20.	Chest circumference	84.5	85.0	85.5	89.0	81.5
21.	Bitrochanteric breadth	32.5	28.3	29.1	32.0	28.6
22.	Hip circumference	88.6	86.0	87.5	92.6	82.5
23.	Upper extremeties—span	152.6	166.2	150.4	158.1	134.1
24.	Upper arm length	31.0	30.5	26.8	29.3	26.0
25.	Forearm length	22.0	23.0	22.8	24.1	19.2
26.	Upper arm circum., greatest			22.6	24.3	21.2
27.	Forearm circum., greatest	20.0	23.8	20.0	19.7	19.0
28.	Lower extremeties—calf circum., greatest		30.7			
29.	Foot length	21.7	21.8	21.5	21.7	19.3
30.	Foot width, greatest	8.7	9.6	9.4	9.2	8.7
31.	Head-length	18.0	21.2	17.3	16.7	16.6
32.	Breadth	16.5	16.8	16.2	15.6	14.7
33.	Bizygomatic breadth	13.0	15.2	13.2	13.8	13.0
34.	Nasion to chin	12.0	12.1	11.2	11.7	11.1
35.	Nose height	6.5	6.6	4.9	5.6	5.5
36.	Ear length	6.5	6.2	6.3	7.0	6.4
37.	Indices					
38.	Span÷stature	105.31	113.7	103.8	109.0	101.9
39.	Height sitting÷stature	50.8	50.9	53.0	51.5	52.4
40.	Build—chest circum.÷stature	58.3	58.1	59.0	61.3	61.9
41.	Biacromial breadth÷stature	22.4	19.4	20.1	22.1	21.7
42.	Bitrochanteric breadth÷biacromial breadth	100.0	78.40	86.9	94.1	91.4
43.	Forearm÷upper arm	70.9	75.4	85.1	82.3	73.8
44.	Foot length÷stature	14.7	14.9	14.7	14.9	14.6
45.	Head breadth÷head length	91.7	79.2	93.6	89.9	88.6
46.	Bizygomatic width÷head width	78.8	90.6	81.5	88.5	88.4
47.	Facial index	92.3	79.6	84.8	84.8	85.4
48.	Bitrochanteric breadth	22.4	19.3	20.0	22.0	21.7
	*Purple	3.0	1.5	10.0	—	—
	*Blue	5.0	1.5	5.0	—	5.0

TABLE 16.—*Continued*

6	7	8	9	10	11	12	13	14
N	N	N	N	PA	N	N	N	N
Alli	Alli	Alli	Alli	Alli	Alli	Alli	Alli	Alli
25	25	30	30	25	35	25	25	30
F	F	M	M	M	F	F	F	F
—	—	—	13, III, 7	2, II, 8	1, II, 2	—	11, III, 1	—
d brown	vd brown	d brown	d brown	hazel	d brown	d brown	d brown	d brown
present	present	present	present	slight	slight	present	present	present
black	bl & d br	black	black	v lb	black	black	black	black
fine	coarse	coarse	medium	medium	coarse	fine	fine	medium
none	none	sparse	sparse	lanugo	none	none	none	none
*22.5	18.5	34.5	20.5	5.5	27.0	56.0	27.0	28.5
33.5	34.5	30.5	29.5	17.5	13.5	14.0	24.0	26.0
32.0	36.0	24.5	36.5	27.5	11.5	17.0	36.0	35.0
11.5	11.0	10.5	13.5	49.5	48.0	13.0	13.0	10.5
smooth	smooth	velvety	smooth	smooth	smooth	velvety	smooth	smooth
dry	dry	dry	dry	dry	dry	dry	dry	dry
good	good	good	good	fair	good	good	good	good
142.6	138.4	150.8	149.8	145.4	142.4	138.4	143.4	145.7
117.4	114.8	125.1	111.9	118.7	116.1	115.5	118.2	119.1
82.7	79.5	89.3	92.2	87.5	84.8	84.3	89.8	87.3
68.8	73.3	79.2	74.4	74.4	73.2	71.3	72.4	74.3
31.8	31.7	34.0	36.7	37.6	32.3	33.3	34.1	34.0
91.2	103.0	89.7	87.8	86.7	96.5	94.2	99.6	98.0
30.0	30.2	29.9	29.5	29.0	29.5	28.6	28.0	30.0
88.2	93.0	81.8	83.5	83.6	91.0	91.6	90.3	94.0
150.0	144.7	162.0	159.6	160.8	148.9	149.7	153.6	152.3
29.6	27.8	31.6	31.2	30.0	27.0	28.3	29.6	29.3
23.0	21.0	25.8	24.0	26.0	22.3	22.1	24.6	22.6
22.0	25.6	24.7	25.1	26.3	25.0	20.7	24.5	26.2
18.4	22.5	24.3	23.3	24.3	21.3	18.2	21.5	21.3
		29.8	29.5	31.7			29.2	29.0
22.3	20.2	23.6	24.6	22.9	21.5	20.6	22.1	21.7
9.3	9.3	10.8	9.3	9.9	8.0	8.4	9.7	8.1
17.3	18.0	19.5	18.1	18.8	18.0	18.0	19.6	18.1
16.4	15.1	16.5	15.3	16.2	15.0	15.3	15.8	14.8
13.9	13.3	14.7	14.1	15.3	13.2	13.8	15.0	13.7
11.2	11.3	12.1	11.3	10.4	10.8	10.0	11.9	11.3
	4.6	4.1	4.9	3.0	4.4	3.2	4.0	4.1
6.0	6.0	6.3	5.7	6.5	5.6	5.6	6.0	5.5
105.2	104.6	107.4	106.5	110.6	104.6	108.2	107.1	104.5
48.2	52.9	52.5	49.7	51.2	51.4	51.5	50.5	51.0
63.9	74.4	59.4	58.6	59.6	67.7	68.0	69.4	67.2
22.3	22.9	22.5	24.5	25.9	22.7	24.1	23.8	23.3
94.3	95.3	87.9	80.4	77.1	91.3	85.9	82.1	88.2
77.7	75.5	81.6	76.9	86.7	85.2	78.1	83.1	77.1
15.6	14.6	15.6	16.4	15.7	15.1	14.9	15.4	15.0
94.8	83.9	84.3	84.5	86.2	83.3	85.0	80.6	81.8
84.8	88.1	89.2	92.2	94.4	88.0	90.2	94.9	92.5
80.6	84.9	82.3	80.1	67.9	81.8	72.5	79.3	82.5
21.0	21.8	19.8	19.6	19.9	20.7	20.6	19.5	20.5
*3.5								

TABLE 16.—*Continued*

		15	16	17	18	19
1.	Normal San Blas or partial albino...	N	N	N	N	N
2.	Locality	Alli	Alli	Alli	Alli	Alli
3.	Age in years (approximate)	45	30	55	25	20
4.	Sex	F	F	M	F	F
5.	Location on pedigree charts	2, II, 14	1, IV, 1	1, II, 9	13, III, 12	14, III, 6
6.	Iris color	d brown	d brown	d brown	d brown	d brown
7.	Epicanthus	present	present	slight	present	slight
8.	Hair color	black	black	black	black	black
9.	Hair texture	fine	medium	fine	coarse	medium
10.	Beard	none	none	sparse	none	none
11.	Skin color:					
	Black	37.0	33.5	25.0	23.5	42.5
	Red	22.0	22.0	31.0	33.5	21.5
	Yellow	31.0	14.5	17.5	17.0	16.0
	White	10.0	30.0	26.5	26.0	20.0
12.	Skin texture	smooth	smooth	smooth	smooth	smooth
13.	Skin humidity	dry	dry	dry	dry	dry
14.	Teeth, general condition	fair	good	good	good	good
15.	Height—total	138.8	144.2	155.3	141.6	145.2
16.	To suprasternal notch	115.7	119.2	127.4	115.7	118.9
17.	To crest of ileum	83.2	87.5	88.8	86.5	87.3
18.	Sitting	69.6	73.3	78.0	72.6	75.0
19.	Biacromial breadth	32.2	33.2	40.1	33.7	35.0
20.	Chest circumference	89.2	97.7	92.5	91.5	90.5
21.	Bitrochanteric breadth	27.3	29.3	31.1	27.6	29.3
22.	Hip circumference	85.5	89.4	92.2	80.3	90.8
23.	Upper extremeties—span	145.4	153.9	171.2	153.3	150.8
24.	Upper arm length	27.2	29.4	29.8	28.9	28.9
25.	Forearm length	21.8	21.7	26.6	22.2	22.7
26.	Upper arm circum., greatest	22.2	24.7	25.6	20.8	22.7
27.	Forearm circum., greatest	20.0	19.8	24.8	27.0	29.7
28.	Lower extremeties—calf circum., greatest	25.2	24.7	30.5	22.9	26.3
29.	Foot length	20.0	21.0	24.0	21.5	21.8
30.	Foot width, greatest	8.0	8.9	10.0	9.2	9.1
31.	Head—length	18.1	17.4	19.2	17.8	17.4
32.	Breadth	15.1	15.1	16.0	15.0	15.1
33.	Bizygomatic breadth	14.0	13.6	14.1	13.7	14.0
34.	Nasion to chin	11.6	10.9	12.0	11.2	10.8
35.	Nose height	4.2	4.1	4.8	4.2	4.0
36.	Ear length	6.2	5.7	7.8	5.9	5.9
37.	Indices:					
38.	Span÷stature	104.8	106.7	110.2	108.3	103.9
39.	Height sitting÷stature	50.1	50.8	50.2	51.3	51.7
40.	Build—chest circum.÷stature	64.2	67.7	59.5	64.6	62.3
41.	Biacromial breadth÷stature	23.2	23.0	25.8	23.8	24.1
42.	Bitrochanteric breadth÷biacromial breadth	84.8	88.3	77.6	81.9	83.7
43.	Forearm÷upper arm	80.1	73.8	89.3	76.8	78.5
44.	Foot length÷stature	14.4	14.6	15.5	15.2	15.0
45.	Head breadth÷head length	83.4	86.8	83.3	84.3	86.8
46.	Bizygomatic width÷head width	92.7	90.1	88.1	91.3	92.7
47.	Facial index	82.9	80.1	85.1	81.8	77.1
48.	Bitrochanteric breadth	19.6	20.3	20.0	19.4	20.1

TABLE 16.—*Continued*

20	21	22	23	24	25	26	27	28
N	PA	N	N	N	N	N	PA	N
Alli	Alli	Alli	Alli	Alli	Alli	Alli	Alli	Alli
25	22	21	25	40	45	45	40	45
M	M	F	M	F	M	F	M	F
9, III, 10	9, III, 5	15, III, 2	2, II, 20	2, II, 1	9, II, 7	9, II, 8	3, III, 11	1, II, 10
d brown	blue	d brown	d brown	d brown	d brown	d brown	hazel	d brown
present	absent	present	present	present	present	present	absent	present
black	flaxen	black	black	black	black	black	flaxen	black
fine	medium	medium	medium	medium	coarse	coarse	medium	medium
sparse	sparse	none	sparse	none	v sparse	none	sparse	none
55.0	11.5	23.0	45.0	26.0	43.5	44.0	16.0	30.0
19.0	19.5	42.0	36.0	29.0	25.5	21.0	15.0	33.5
13.0	16.5	23.5	11.5	25.0	16.5	19.5	13.5	26.0
13.0	52.5	11.5	7.5	20.0	14.5	15.5	55.5	10.5
velvety	rough	smooth	smooth	smooth	smooth	smooth	rough	smooth
dry	dry	dry	dry	dry	dry	dry	dry	dry
fair	good	good	good	good	good	good	fair	good
150.7	152.9	133.7	149.5	136.7	151.1	138.3	146.4	140.9
124.2	125.6	109.0	121.2	110.3	123.1	113.1	120.0	115.6
87.8	89.5	81.0	88.5	79.2	88.7	78.7	86.8	84.3
75.8	76.2	75.4	75.4	71.0	75.1	72.5	71.4	71.2
36.2	35.8	31.2	38.0	33.3	37.5	33.1	35.1	31.1
87.3	85.7	93.5	86.8	88.0	87.3	100.0	82.8	92.5
29.3	28.2	28.7	28.0	27.6	31.2	31.1	26.9	28.7
78.8	82.8	85.3	82.3	84.8	87.3	86.6	77.4	81.1
170.4	166.2	141.6	157.2	146.8	165.5	147.0	161.7	147.5
31.4	31.3	26.5	29.3	28.4	30.3	27.2	29.3	25.5
25.1	26.0	21.0	23.2	21.1	25.8	21.2	23.3	21.2
24.0	25.5	21.2	24.3	22.9	25.6	24.8	20.7	22.0
22.8	24.2	19.3	25.3	19.6	25.0	19.8	19.5	20.4
29.8	31.2	25.0	30.0	24.3	31.0	25.6	27.2	25.2
23.6	23.2	20.4	23.3	20.6	22.7	21.3	21.7	21.0
9.8	9.9	7.7	9.5	8.3	8.6	8.4	8.8	8.1
18.1	18.7	17.2	18.4	17.8	19.2	17.4	18.3	18.0
15.2	15.6	14.0	16.0	15.3	16.6	16.0	15.5	15.1
14.1	14.1	13.1	14.4	13.9	15.0	14.1	13.9	13.8
11.7	10.3	9.6	12.0	11.2	12.1	9.9	12.1	10.1
4.2	4.0	3.9	4.1	3.8	4.9	4.7	4.8	4.5
6.2	6.1	5.0	6.2	5.8	6.2	5.9	7.1	5.8
113.1	108.7	105.9	105.2	107.4	109.5	106.3	110.5	104.7
50.3	49.8	56.4	50.4	51.9	49.7	52.4	48.8	50.5
57.9	56.0	69.9	58.0	64.3	57.7	72.3	56.5	65.6
24.0	23.4	23.3	25.4	24.4	24.8	23.9	23.9	22.1
80.9	78.8	91.9	73.7	82.9	83.2	93.9	76.6	92.3
79.9	83.1	79.2	79.2	74.3	85.1	77.9	79.5	83.1
15.7	15.2	15.3	15.6	15.1	15.0	15.4	14.8	14.9
83.9	83.4	81.4	86.9	85.9	86.5	91.9	84.7	83.9
92.8	94.0	93.6	90.0	90.8	90.4	88.1	89.7	91.4
82.9	73.0	73.3	83.3	80.6	80.7	70.2	87.1	73.2
19.4	18.4	21.4	18.7	20.1	20.6	22.4	18.3	20.3

TABLE 16.—*Continued*

		29	30	31	32	33
1.	Normal San Blas or partial albino	N	N	PA	N	N
2.	Locality	Alli	Alli	Porto	Porto	Porto
3.	Age in years (approximate)	32	22	25	30	40
4.	Sex	M	M	M	F	M
5.	Location on pedigree charts	10, II, 3	1, III, 8	12, II, 8	12, II, 9	5, II, 7
6.	Iris color	d brown	m brown	hazel	d brown	d brown
7.	Epicanthus	present	present	slight	slight	present
8.	Hair color	black	black	flaxen	black	black
9.	Hair texture	fine	medium	medium	medium	fine
10.	Beard	sparse	v sparse	v sparse	none	sparse
11.	Skin color					
	Black	26.0	14.0	5.5	38.5	
	Red	41.5	43.5	9.5	32.0	
	Yellow	24.0	32.0	15.0	23.0	
	White	8.5	10.5	70.0	6.5	
12.	Skin texture	smooth	smooth	rough	smooth	smooth
13.	Skin humidity	dry	dry	dry	dry	dry
14.	Teeth, general condition	fair	good	good	good	good
15.	Height—total	148.3	146.3	137.6	134.5	153.7
16.	To suprasternal notch	120.3	119.3	113.0	110.8	125.8
17.	To crest of ileum	83.4	81.7	75.8	80.3	86.5
18.	Sitting	73.8	74.1	68.2	66.5	75.4
19.	Biacromial breadth	36.0	36.2	35.5	33.0	30.6
20.	Chest circumference	89.2	87.6	84.2	97.7	88.6
21.	Britochanteric breadth	29.0	28.3	27.3	29.0	30.4
22.	Hip circumference	82.9	79.7	78.8	87.3	83.7
23.	Upper extremeties—span	159.2	156.3	144.4*	147.3	168.4
24.	Upper arm length	27.3	27.6	25.2	25.2	26.7
25.	Forearm length	24.6	25.2	23.0	19.2	26.7
26.	Upper arm circum., greatest	24.6	23.6	23.2	22.1	25.2
27.	Forearm circum., greatest	23.6	24.2	22.6	20.2	24.7
28.	Lower extremeties—calf circum., greatest	29.6	29.5	28.2	26.3	29.3
29.	Foot length	22.1	22.4	21.1	20.1	22.6
30.	Foot width, greatest	9.4	9.5	8.9	8.4	9.7
31.	Head—length	18.3	18.1	18.2	18.3	19.1
32.	Breadth	15.9	15.4	15.2	15.7	15.9
33.	Bizygomatic breadth	14.4	14.1	14.1	14.1	14.1
34.	Nasion to chin	11.0	11.2	9.3	10.1	11.1
35.	Nose height	4.4	4.6	4.1	4.4	4.5
36.	Ear length	6.3	7.0	5.9	5.1	5.9
37.	Indices					
38.	Span÷stature	107.3	106.8	104.9	109.5	109.6
39.	Height sitting÷stature	49.8	50.6	49.6	49.4	49.1
40.	Build—chest circum.÷stature	60.1	59.8	61.1	72.6	57.6
41.	Biacromial breadth÷stature	24.3	24.7	25.8	24.5	19.9
42.	Bitrochanteric breadth÷biacromial breadth	80.6	78.2	76.9	87.9	89.3
43.	Forearm÷upper arm	90.1	91.3	91.3	85.1	94.4
44.	Foot length÷stature	14.9	15.3	15.3	14.9	14.7
45.	Head breadth÷head length	86.9	85.1	83.5	85.8	83.2
46.	Bizygomatic width÷head width	90.6	91.6	92.8	89.8	88.7
47.	Facial index	76.4	79.4	65.9	71.6	78.7
48.	Bitrochanteric breadth	19.5	19.3	19.8	21.5	19.7

TABLE 16.—*Continued*

34	35	36	37	38	39	40	41	42
N	N	N	N	N	N	N	N	N
Porto	Porto	Porto	Porto	Porto	Alli	Alli	Alli	Alli
35	30	32	30	35	30	18	22	23
F	M	M	F	M	M	F	F	F
5, II, 8	6, III, 6	8, II, 1	6, III, 8	6, III, 9	1, III, 5	1, III, 9	3, III, 19	1, III, 7
d brown	d brown	brown	d brown	d brown	d brown	d brown	d brown	m brown
present	absent	present	present	present	present	present	present	present
black	black	black	black	black	black	br–bl	black	black
medium	coarse	fine	fine	medium	medium	medium	medium	medium
none	sparse	sparse	none	sparse	sparse	none	none	none
	23.5	32.5	32.0	32.0	13.0	13.0	22.0	5.5
	49.5	46.5	22.0	22.0	43.5	42.0	31.0	29.5
	16.5	14.0	31.0	31.0	32.5	34.5	41.0	46.5
	10.5	7.0	15.0	15.0	11.0	10.5	6.0	18.5
smooth	smooth	sl rough	smooth	smooth	smooth	smooth	smooth	smooth
dry	dry	dry	dry	dry	dry	dry	dry	dry
good	good	good	good	good	fair	fair	good	good
143.9	158.4	146.2	140.0	149.3	144.4	137.0	138.5	136.5
119.2	129.8	119.3	115.9	123.7	120.1	113.4		111.0
86.2	88.9	84.2	83.0	87.7	84.3	84.2	85.5	86.8
70.3	79.0	72.0	73.5	73.8	69.7	72.3	74.4	70.8
32.9	40.2	37.1	33.3	36.0	34.9	33.2	34.2	33.2
86.6	92.0	91.7	94.7	88.1	81.5	96.0	100.1	95.7
29.6	30.2	28.7	29.7	28.3	28.1	29.3	30.2	29.0
83.7	88.3	80.5	89.8	84.2	77.7	84.7	87.7	86.2
151.7	173.0	162.3	148.0	166.3	162.9	148.4	144.9	141.7
28.3	27.6	28.2	22.6	26.7	29.3	26.4	26.0	24.8
21.4	27.0	25.3	21.0	26.1	24.1	24.0	21.3	18.7
24.3	27.1	25.6	25.2	24.3	22.8	26.5	27.0	22.1
21.7	26.0	23.2	22.5	23.7	22.8	22.2	22.3	20.0
25.6	31.6	30.4	27.4	27.5	26.1	27.5	29.0	25.2
21.9	23.8	22.1	22.3	22.6	22.3	21.1	20.3	19.3
8.8	9.3	8.9	9.2	10.1	9.1	8.3	9.4	7.3
18.1	19.2	17.5	18.0	18.4	18.1	18.2	17.2	17.2
15.2	16.7	15.5	15.5	15.3	15.0	15.1	15.0	14.6
14.1	15.5	14.1	14.4	15.0	13.6	14.0	13.9	13.5
10.0	11.3	11.0	10.6	11.0	10.0	10.3	10.5	10.7
4.4	4.8	4.9	4.0	4.8	3.0	4.1	3.7	4.3
6.0	6.4	6.1	5.2	6.6	5.6	5.3	6.0	5.3
105.4	109.2	111.0	105.7	111.4	112.8	108.3	104.6	103.8
48.9	49.9	49.2	52.5	49.4	48.3	52.8	53.7	51.9
60.1	58.0	62.7	67.6	59.0	56.4	70.0	72.2	70.1
22.9	25.4	25.4	23.8	24.1	24.2	24.2	24.7	24.3
89.9	75.1	77.4	89.2	78.6	84.6	88.3	88.3	87.3
75.6	97.8	89.7	92.9	97.8	82.3	90.9	81.9	75.4
15.2	15.0	15.1	15.9	15.1	15.4	15.4	14.6	14.1
83.9	86.9	88.6	86.1	83.2	82.9	82.9	87.2	84.9
92.8	92.8	90.9	92.9	98.0	90.7	92.7	92.7	92.5
70.9	72.9	78.0	73.6	73.3	73.5	73.6	75.5	79.3
20.5	19.0	19.6	21.2	18.9	19.4	21.3	21.8	21.2

TABLE 16.—*Concluded*

		43	44	45	46
1.	Normal San Blas or partial albino	N	N	N	N
2.	Locality	Alli	Alli	Alli	Alli
3.	Age in years (approximate)	17	60	25	25
4.	Sex	M	F	F	F
5.	Location on pedigree charts	1, III, 11	1, I, 4		
6.	Iris color	m brown	brown	m brown	d brown
7.	Epicanthus	present	present	present	present
8.	Hair color	black	black	black	black
9.	Hair texture	fine	coarse	coarse	medium
10.	Beard	sparse	none	none	none
11.	Skin color				
	Black	15.0	15.0	15.0	26.0
	Red	37.0	37.5	37.0	31.5
	Yellow	36.5	36.5	38.0	31.5
	White	11.5	11.0	10.0	11.0
12.	Skin texture	smooth	wrinkled	smooth	smooth
13.	Skin humidity	dry	dry	dry	dry
14.	Teeth, general condition	good	fair	good	good
15.	Height—total	149.2	143.6	144.9	137.5
16.	To suprasternal notch	122.2	119.1	118.3	113.7
17.	To crest of ileum	87.0	86.2	88.0	82.5
18.	Sitting	76.3	67.8	74.8	71.8
19.	Biacromial breadth	36.3	34.3	33.1	33.4
20.	Chest circumference	87.6	96.0	103.5	106.0
21.	Bitrochanteric breadth	28.7	29.0	29.3	30.4
22.	Hip circumference	79.7	83.5	91.5	92.0
23.	Upper extremeties—span	158.4	155.2	154.8	145.1
24.	Upper arm length	27.0	24.1	29.2	26.1
25.	Forearm length	24.1	22.1	22.4	20.1
26.	Upper arm circum., greatest	24.2	24.5	26.0	25.7
27.	Forearm circum., greatest	23.8	21.5	22.4	21.2
28.	Lower extremeties—calf circum., greatest	30.0	26.6	28.8	25.3
29.	Foot length	22.7	21.8	21.3	20.7
30.	Foot width, greatest	8.9	8.2	8.4	8.1
31.	Head—length	19.3	18.4	18.3	17.8
32.	Breadth	15.9	15.8	15.7	15.5
33.	Bizygomatic breadth	14.0	13.7	14.2	14.1
34.	Nasion to chin	11.3	11.0	11.1	10.6
35.	Nose height	4.4	4.5	4.1	4.1
36.	Ear length	5.7	6.1	5.1	5.2
37.	Indices				
38.	Span÷stature	106.2	108.1	106.8	105.5
39.	Height sitting÷stature	51.1	47.2	51.6	52.2
40.	Build—chest circum.÷stature	58.7	66.8	71.4	77.0
41.	Biacromial breadth÷stature	24.3	23.9	22.8	24.3
42.	Bitrochanteric breadth÷biacromial breadth	79.1	84.5	88.5	91.0
43.	Forearm÷upper arm	89.3	91.7	76.7	77.0
44.	Foot length÷stature	15.2	15.1	14.7	15.1
45.	Head breadth÷head length	82.4	85.9	85.8	87.1
46.	Bizygomatic width÷head width	88.1	86.7	90.4	90.9
47.	Facial index	80.7	80.3	78.2	75.2
48.	Bitrochanteric breadth	19.2	20.1	20.2	22.1

Summary

The San Blas Indians studied, due to relatively close inbreeding, to "purity" of blood, and to the presence of a clearly differentiated group in their midst, offer unusual opportunities for the collection of valuable genetical and anthropological data.

They may be said to contain two distinct groups (a) Normal Indians and (b) Partial Albino Indians.

The partial albino Indians are the frequently reported "White Indians of Darien." Their appearance is obviously the expression of a homozygous recessive condition, due originally to a mutation in one or more genes. They cannot be considered the result of previous miscegenation with Caucasians as they are clearly Indians, not hybrids.

The partial albino males are in general shorter and slighter than the normal Indian males, though their proportions clearly indicate their Indian origin.

They seem to be more susceptible to disorders of the skin and eyes than do the normal Indians.

That the condition "white Indian" is genetical in nature is amply demonstrated by the data contained in the family histories. The white Indians thus hold potentialities for race production.

Due to the fact that they do not reproduce themselves, on account of artificial restrictions, and since they do not occur by themselves in definite geographical areas there may be some question as to the desirability of calling the white Indians a race.

Their present large number is maintained for the most part by frequent matings of related recessive-carrying browns.

The Indians of the San Blas Coast are unusually short in stature, and exhibit a markedly high relative span. They are brachycephalic; have relatively broad faces and medium long legs. The torso is "thick-set," showing high relative biacromial and bitrochanteric breadth, and chest and hip girth.

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For other references used in tables of comparative data see Martin.

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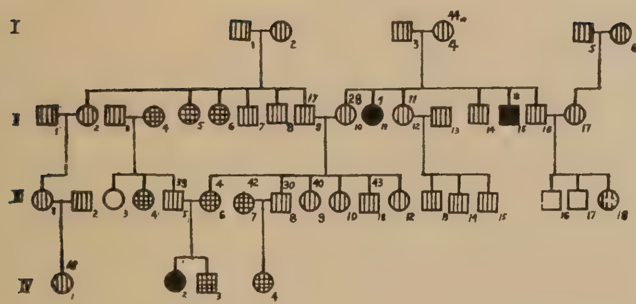

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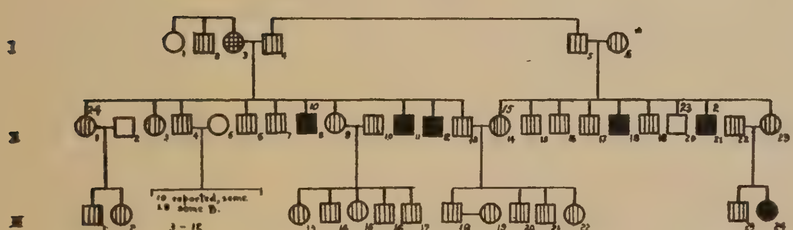

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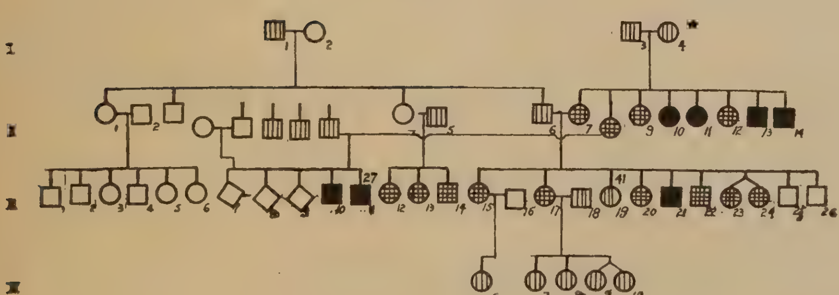

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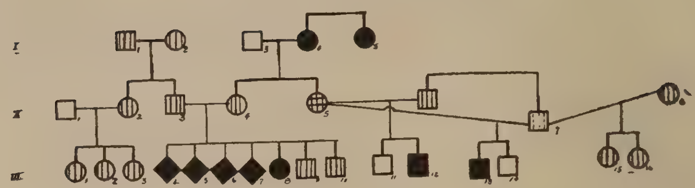

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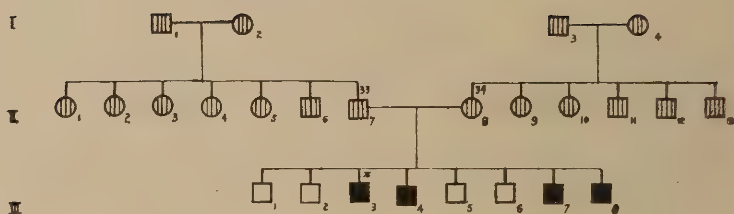

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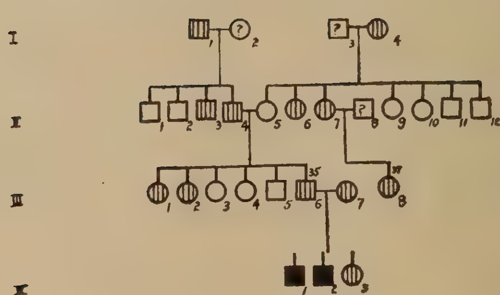

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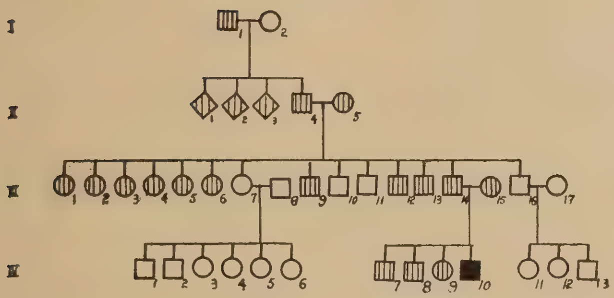

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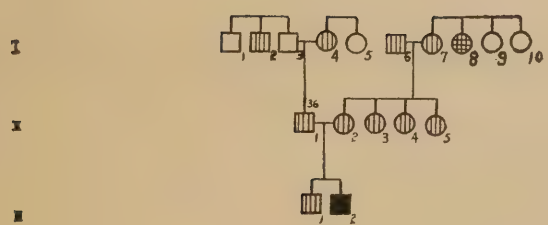

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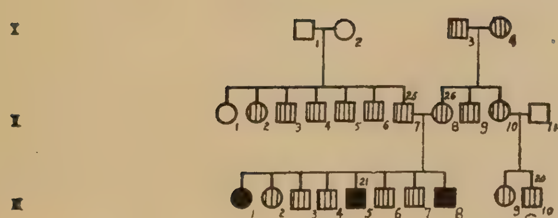

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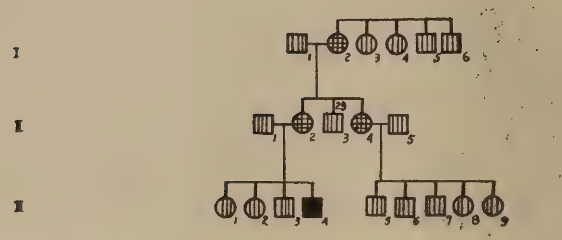

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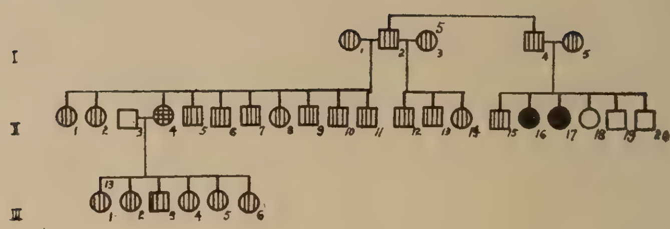

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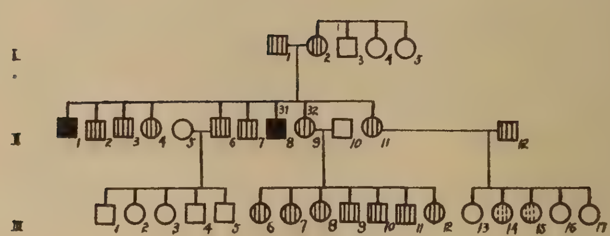

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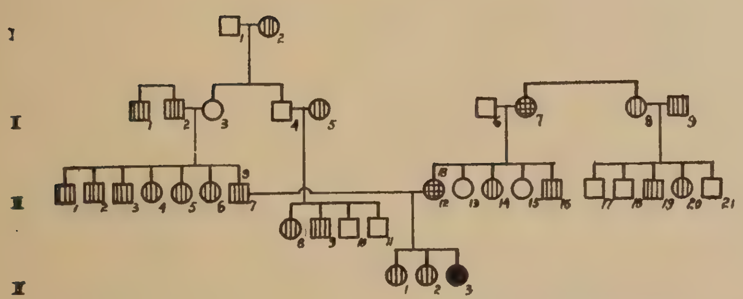

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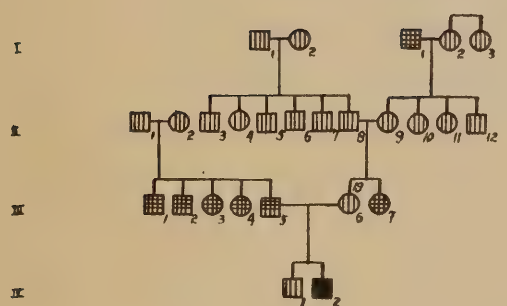

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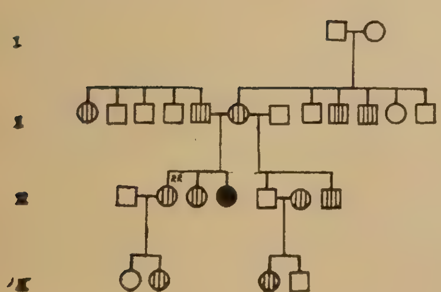

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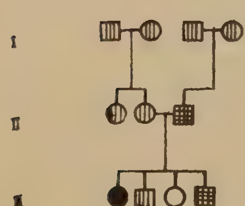

ANTHROPOLOGICAL STUDIES ON NICARAGUAN INDIANS[1]

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Introduction. Relatively little is known of the bodily features of Central-American Indians. For this reason it would seem worth while to place on record the following observations, made by the author in the course of his second trip to Nicaragua, even though these observations constitute but a meagre contribution, being based upon only two small series. The number of pure-blooded Indians on the East coast of Nicaragua is rapidly dwindling, influenza, tuberculosis, and malaria taking a heavy toll among them. During seven weeks in the field only a little over one hundred Indians, other than the so-called Miskitos (who are largely intermixed with negroes), were encountered. Of these a total of 37 adult men could be measured, and this only after their natural shyness and reluctance had been overcome with much persuasion. It was found quite impossible to examine any of the women. Very little could have been accomplished without the effective intercession of Mr. Grossmann, the superintendent of the Moravian Mission in the eastern part of Nicaragua, who has been active among these Indians for the past 35 years. The author wishes to express his gratitude to Mr. Grossmann for his kind help and reliable information in connection with these investigations.

The two groups studied belong to the Rama and Sumu tribes and number 25 and 12 adult men respectively. The Rama Indians were visited on a small island (Rama Cay) in the Bluefields lagoon, about 10 miles south of Bluefields. These Indians came originally from the interior of eastern Nicaragua, from where they had migrated about 75 years ago to Punta Gordas (near Monkey Point) on the coast. After a tribal war part of them (according to Mr. Grossmann, about 200) came to Rama Cay, where they have lived in practically complete isolation ever since. Their main occupation is fishing, but occasionally they go hunting on the nearby mainland. An influenza epidemic has decimated their number a great deal, so that inbreeding is even more pronounced

[1]This paper is one of a series of reports on material and data obtained in 1924 in Nicaragua, by an expedition from the Johns Hopkins Medical School. The personnel of the expedition consisted of Dr. A. H. Schultz, Dr. G. B. Wislocki, Dr. F. F. Snyder, and Mr. O. O. Heard. The expenses were defrayed in part by a grant from the Linton Fund of the Johns Hopkins Medical School and by an additional grant from the Carnegie Institution of Washington.

to-day than before. According to the Mission records there are many more girls than boys. The language of the Rama Indians is quite different from that of the Sumu or that of the Miskito Indians.

The Sumu Indians were met with in the region of the Princapolka river which enters the Caribbean Sea some 80 miles north of Bluefields. Their few small settlements are scattered along the river course anywhere from 70 to 110 miles from the coast. These natives live by hunting and fishing and occasionally raise some corn and bananas; in general they are even poorer than the Ramas.

The author has been assured that the strict customs of both the Sumus and the Ramas prevent intermarriage outside the tribe.

Measurements. It was originally planned to take a larger number of measurements and observations, but unfortunately quite a few had to be omitted on account of the objections of the natives. Those finally selected are here listed; their detailed technique has been described by Martin (1914) under the numbers mentioned after each measurement. Stature (1), shoulder height (8), middle finger (11), arm length (8–11), sitting height (23), biacromial breadth (35), hand length (49), hand breadth (52), foot length (58), foot breadth (59) (58 and 59 taken with the foot on a bench, so that the body weight does not rest on the foot). Head measurements: length (1), breadth (3), minimum frontal breadth (4), bizygomatic breadth (7), bigonial breadth (8), interocular breadth (9), nose breadth (13), mouth breadth (14), auricular head height (15), total face height (18), upper face height (19), nose height (21), ear height (29), and ear breadth (30). All the absolute measurements in this paper are given in millimeters.

Age. The age of the Rama Indians studied could be ascertained exactly with the help of the missionary; it varied between 21 and 40 years, with an average of 29 years. The age of the Sumus was obtained only by estimation; its average and range is most likely the same as in the Ramas, except for one individual (No. 6) who was about 50, certainly not over 55 years old.

Skin color. The skin color was compared with the skin color scale of von Luschan, invariably over the middle of the corpus sterni, a region

TABLE 1. PERCENTAGES OF CASES WITH A GIVEN SKIN COLOR (SCALE OF V. LUSCHAN).

No. of color	Sumu	Rama
20	25	4
21	9	8
22	33	32
23	33	20
24	—	12
25	—	24

which in all the Indians examined is not exposed to the sun, being constantly covered by a shirt. From Table 1 it can be seen that among the Rama Indians there occur some slightly darker colors than in the Sumus, who, on an average, tend to be somewhat lighter.

Hair. In both groups the hair color was found to be black without a single exception. No cases of gray or white hair occurred nor was any degree of baldness noted. The hair form was determined to be perfectly straight in all but two of the Sumus and in all but one of the Ramas. The three exceptions showed very long low waves.[2] The hair texture was, as a rule, not quite as coarse as in North American Indians.

Chest hair was definitely lacking in all Sumus and in all but one Rama; the latter (No. 19) had a thin coat of short black hairs in the area between the nipples. This fact may indicate some white admixture, but since no other point augmented this suspicion, the individual was not excluded from the series.

A beard was present in 5 Sumus and in 6 Ramas; in all these it was very scantily developed, a few scattered hairs reaching at best a length of two inches. The development of the moustache was noted as follows: "none" in 2 Sumus and 3 Ramas; "very sparse" and only over the corners of the mouth in 7 Sumus and 17 Ramas; "moderate" in 3 Sumus and 3 Ramas; and "marked" (but as compared with the average moustache in whites, still "sparse") in 2 Ramas.

Stature. As shown by Table 2 the stature in these Nicaraguan Indians is quite low. The Sumus are on an average nearly 8 cm. shorter than the Ramas. A stature below 1612 mm. occurs in two-thirds of the Sumus but in only one fifth of the Ramas. The average stature of the Sumus is about the same as that of the South American Machiganga (♂ 1559 mm.) and Quichua (♂ 1584 mm.) Indians (Ferris, 1921), and as that of the Indians of Southern Mexico (♂ 1575 mm.; Starr, 1902).

Table 2. Averages and Ranges of Variation of Stature and Percentage Distribution of Cases in Five Stature Classes, 63 mm. Each.

Stature	Ave.	Min.	Max.	1420–1483	1484–1547	1548–1611	1612–1675	1676–1739
Sumu	1581.6	1427	1680	8	17	42	25	8
Rama	1660.8	1538	1738	—	8	12	40	40

Sitting height. The sitting height is proportionately short in both groups of Indians, the sitting height-stature ratio amounting on an average in the Sumus to 50.83, in the Ramas to 50.60. According to Bean (1922), the general average of this proportion in American Indians

[2]The degree of this waviness did not surpass grade *c* of the series of diagramatic hair forms, pictured by Martin (1914, p. 189). Since there was never more than one wave, this might have been caused artificially.

is higher, namely, in males 52.3. The tables of Bardeen (1923), containing average relative sitting heights in male Indians, list only three groups with values below that of the Sumus, namely, the Machigangas (50.1), the Arawaks (50.7), and the Pimas (50.7), whereas the 23 other groups mentioned have values above those of the Nicaraguan Indians.

Shoulder breadth. The greatest width between the two acromial processes in percentage of the stature was in the Sumus 23.32 and in the Ramas 23.38. If these values are compared with the compilation of the averages for this proportion in different human races (Martin, 1914), it becomes evident that these Indians are relatively broad-shouldred. This is a further support of the general rule, that the shorter a race the relatively broader the shoulder width.

Upper extremity. The total arm length (on the left) averages in the Sumus 725.0 mm., in the Ramas 735.6 mm. In its percentage relation to the stature the total arm length in the Sumus amounts to 46.21 on an average, with a range extending from 44.2 to 47.9, and in the Ramas to 44.26 on an average, ranging between 42.5 and 46.1. Judging by the values of this proportion quoted by Martin for American aborigines, the Sumus are fairly long-armed, whereas the Ramas fall among the groups characterized by a medium, if not a short arm length.

Hand. The hand length (left) in relation to the stature is slightly greater in the Ramas (10.83) than in the Sumus (10.76). An almost identical average for this relative measurement exists in the male Quichua Indians, namely 10.8 (Ferris, 1921). Compared particularly with whites and negroes, the hands of these Indians are very short.

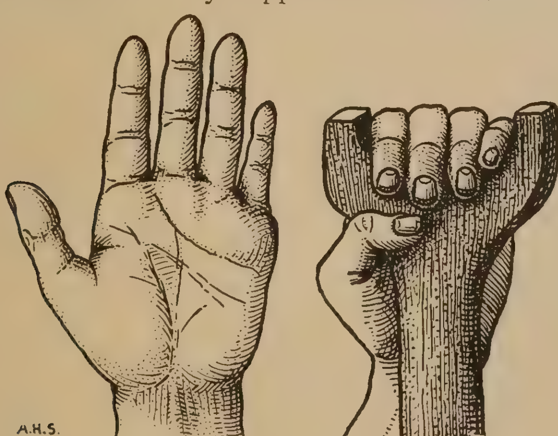
Of the total arm length the hand constitutes on an average 23.51 per cent in the Sumus and 24.47 per cent in the Ramas. In this proportion the difference between the two is much more pronounced than in the hand length-stature ratio. The Ramas with their relatively short arms have a proportionately longer hand than the Sumus with their long arms.

The hand index is slightly lower in the Ramas (44.30) than in the Sumus (44.97), but with the scarcity of material such small differences have little if any significance. Both these averages can be considered as indicating a hand of more than medium relative breadth when compared with values in other races. The average hand index in men ranges according to Martin from 38.9 in Massai to 48.1 in the population of Baden, Germany; the mean for the 21 races listed by this author lies at 43.7. In connection with another, as yet unpublished, study the author obtained an average hand index of 43.88 for adult male negroes and one

of 45.38 for adult white men (both groups from the eastern United States).

Fingers. The relation in length between the second and fourth finger is of considerable racial interest. Among the Sumus the annularis projected further than the index finger in two-thirds of the cases, in one-third these two fingers were of equal length. Among the Ramas in 67 per cent of the individuals the fourth finger was longer than the second, in 24 per cent the two fingers were of equal length, and in only one case was the index finger the longer. A finger formula reading II⟩IV is therefore exceedingly rare in the Indian; it is known to occur only exceptionally in the negro, never in monkeys or apes, but with considerable frequency in the white race. The reversed formula, IV⟩II, is rather uncommon in whites, but is the rule in negroes and, apparently, in Indians.

The little finger of all Rama and, to a lesser extent, the Sumu men seems almost rudimentary and stands inside of the direction of the ulnar edge of the palm, as if it had been crowded toward the fourth finger (see Figure 1). All these Indians spend a great deal of their time in paddling canoes and the handle of their paddles is shaped in a manner which squeezes the inserted fingers II to V of the adult hand. It seems quite likely that the above mentioned position and smallness of the fifth finger is not an inherited racial character but the direct result of the narrow paddle handles. This assumption was strengthened by finding that these conditions are not yet apparent on the hands of children.



Rama Hand Grip on paddle

FIGURE 1. Sketch of hand of a Rama Indian (♂, ad.) and of the manner in which the handle of a Nicaraguan paddle is gripped. Note the position of the little finger

Lower extremity. The sitting height of the Nicaraguan Indians was found to be short relative to the stature, a fact from which one may conclude that the lower limbs must be proportionately long. The length of the latter (below the ischia) in the Sumus amounts on an average to 49.17 per cent of the stature, and in Ramas to 49.40 per cent. The range of variation in this relative leg length extends from 46.1 to 51.3.

Foot. The foot length (left), in relation to the stature, averages in Sumus 15.28, in Ramas 15.16. In the Machiganga Indians the relative foot length amounts to 14.6 and in the Quichua Indians to 15.0 (Ferris, 1921). Figures quoted by Martin for American aborigines range from 13.7 to 15.2. It can be stated, therefore, that the Nicaraguan Indians have rather long feet.

The average foot index in the Sumus is 39.05, in the Ramas 39.92. These values indicate proportionately narrow feet. In the Quichuas this index amounts to 42.4, in the Machigangas to 41.8 (Ferris, 1921), and in Colorado Indians to 44.8 (quoted from Martin).

Head size. The size of the head is best characterized by the arithmetic mean of head length, breadth, and height, or the so-called cephalic module. This measurement amounts in the Sumus on an average to 151.4, in the Ramas to 155.9 mm. In relation to the stature the cephalic module averages in the former 9.59 and in the latter 9.40, i.e., the taller Ramas have proportionately a somewhat smaller head. This correlation holds true also within a given race, inasmuch as, generally speaking, the greater the stature of an individual the relatively smaller is the head. Figure 2 serves as an illustration of this rule. The example of the Rama

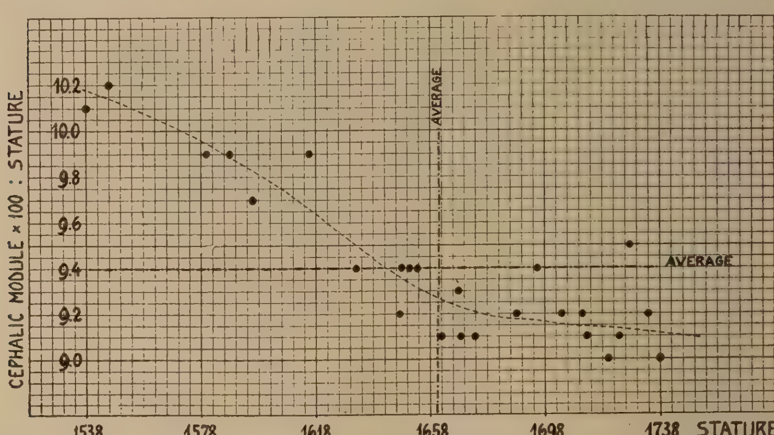


FIGURE 2. Correlation between stature and relative cephalic module in Rama Indians.

Indians would indicate that individuals of less than average stature have in general a relative head size above the average, and vice versa.

The following comparison of the relative head sizes in various groups of male American Indians (listed according to increasing stature) shows clearly that the Sumus have proportionately small heads, whereas in the Ramas the head is of typical size (for Indians) in relation to their stature.

Race	Author	Stature	Relative cephalic module
Machiganga	Ferris, 1921	1559	9.73
Sumu	Schultz, 1926	1582	9.59
Quichua	Ferris, 1921	1584	10.00
Otomi	Hrdlička, 1912	1593	9.73
Aztec	Hrdlička, 1912	1610	9.58
Tarasco	Hrdlička, 1912	1631	9.50
Cora	Hrdlička, 1912	1641	9.63
Rama	Schultz, 1926	1661	9.40
Apache	Hrdlička, 1908	1697	9.40
Choctaw	Collins, 1925	1714	9.36
Pima	Hrdlička, 1908	1718	9.23

Cephalic index. Both the Sumus and the Ramas are on an average hyperbrachycephalic, the cephalic index of the former being 89.48 and of the latter 85.92. The range of variation and the distribution of the individual values is shown for both groups in Figure 3. The Sumus have

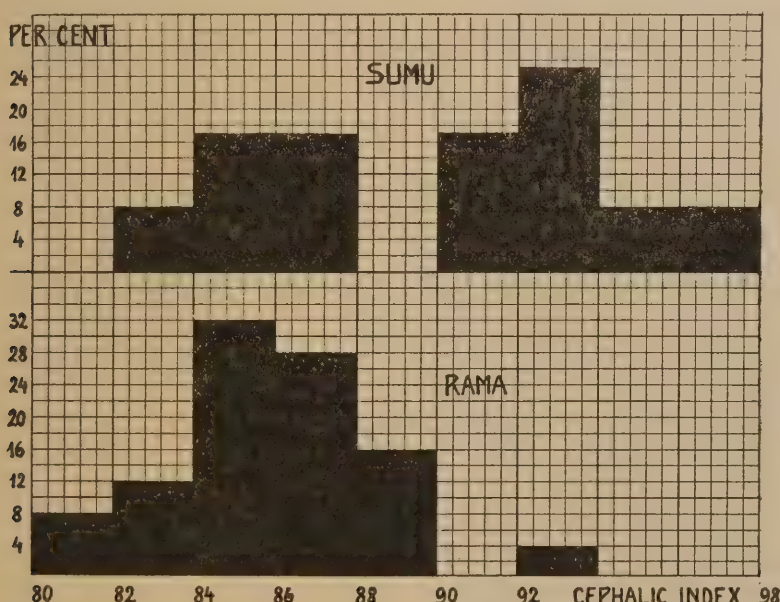


FIGURE 3. Percentage distribution of the cephalic index among nine classes of 1.9 index units each.

such a high cephalic index that it stands almost unsurpassed by any other American aborigines.[3]

Head height. The Ramas have a somewhat higher head than the Sumus, as evidenced by the average percentage relation between the head height and the mean of head length and head breadth, which amounts in the former to 79.84, in the latter to 78.71. These values are somewhat below that of male Choctaw Indians (average 80.4, Collins, 1925), and they fall well within the range of the values given by Hrdlička (1925) for the same index in whites.

Forehead. The Ramas, with their greater stature and the larger absolute head size, have a slightly narrower forehead (107.1 mm.) than the small Sumus (107.4 mm.). In relation to the greatest breadth of the head the breadth of the forehead (transverse fronto-parietal index) averages in Ramas 69.28 and in Sumus 69.80. These are rather high values for brachycephalic races.

Morphological face index. Both groups of Nicaraguan Indians are on an average mesoprosopic, the Sumus having a face index of 84.82, the Ramas one of 85.20. Male Shoshoni Indians average for this index 80.5 (Boas, quoted by Martin), male Sioux Indians 83.6 (Sullivan, 1920), male Apache Indians 78.8, male Pima Indians 84.6 (Hrdlička, 1908), and male Quichua Indians 82.9 (Ferris, 1916). Judging by these meagre comparative data the Nicaraguan Indians have proportionately narrow faces.

Bizygomatic breadth. This same conclusion is also reached when the width of the face is expressed in relation to the width of the head (transverse cephalo-facial index). This proportion amounts on an average to 91.55 in Sumus and to 92.63 in Ramas. In male Quichua Indians this index is on an average 96.10 (calculated from the figures of Ferris, 1921, for the two breadth dimensions). In other male Indians this index amounts to 94.30 in Apaches, 94.90 in Mexicans, 95.30 in Peruvians, 97.19 in Ojibways, 98.63 in Pimas (quoted from Wissler, 1917), and 94.8 in Athapascans (quoted from Martin, 1914). These are all much higher figures than those found in the Nicaraguan Indians; the latter, therefore, have an unusually narrow face, not only in relation to the face height but also in proportion to the head breadth. It may be mentioned here

[3]Boas (quoted by Martin) found an average cephalic index in Wichita Indians of both sexes of 89.5 and one of 89.7 in male California Indians.

The author is convinced that the exceedingly broad heads of the Sumus and Ramas are not the result of artificial deformation, since no indication of the latter was found in any of the subjects measured, and the missionaries, when questioned on this point, emphatically denied the existence of such a practice among any Indians in Eastern Nicaragua.

PLATE I. Heads of adult Rama men and of a Rama girl (No. 38) (O. O. Heard photo.)

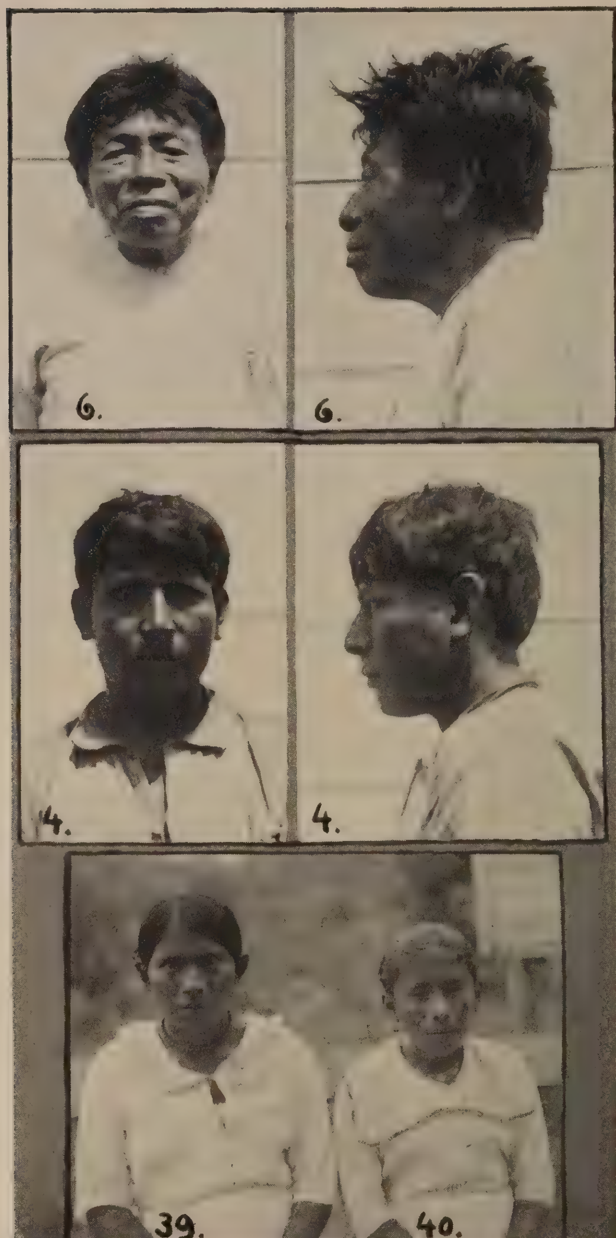


Plate II. Heads of Sumu men and of two Sumu women (O. O. Heard photo.). Due to adverse climatic conditions, other Indian photographs did not turn out satisfactory.

that in spite of the small width between the zygomatic arches the malar bones are quite prominent in the great majority of the Nicaraguan Indians.

Bigonial breadth. The width between the angles of the lower jaw follows to a considerable extent (within one race and one sex) the width between the zygomatic arches, as is shown by Figure 4. The average relation between these two measurements is somewhat different in Sumus and Ramas. In the latter the bigonial breadth constitutes 78.21 per cent of the face breadth, in the former only 75.85 per cent; i. e., the Ramas have a relatively broader mandible.

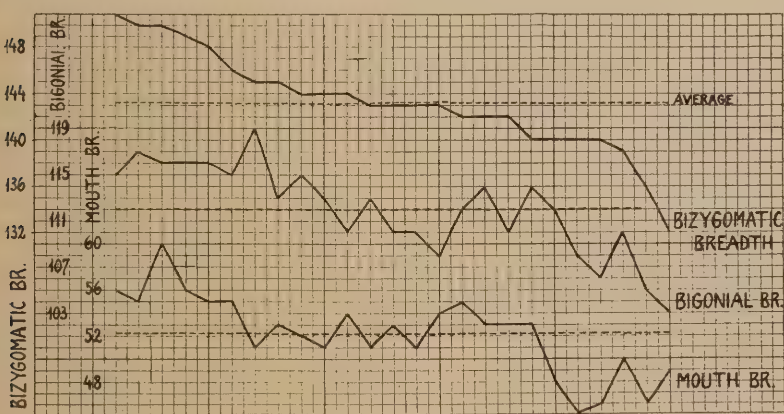


FIGURE 4. Bizygomatic breadth, bigonial breadth, and breadth of mouth in Rama Indians, arranged according to decreasing bizygomatic breadth.

Mouth. From Figure 4 it can be concluded that in general in individuals of one race the broader the face the broader is the mouth. In the Sumus the breadth of the mouth ranges from 48 to 64 mm., with an average of 55.6 mm., whereas the taller Ramas have an average of only 52.2 mm. with a range from 45 to 60 mm. This racial difference in the breadth of the mouth is still more clearly brought out by expressing it in percentage of the bizygomatic breadth. This relative mouth width averages 39.49 in Sumus and 36.45 in Ramas.

The lips were "moderate" in 75 per cent of the Sumus and in 28 per cent of the Ramas, they were of "medium" thickness in 25 per cent of the former and in 64 per cent of the latter, while 8 per cent of the Ramas had lips of "more than medium" thickness. In general, therefore, the Sumus have thinner lips than the Ramas.

A slight degree of under-bite occurred in one Sumu, 9 others showed edge-to-edge bite, and in the two remaining cases (17%) there existed

slight over-bite. In the Ramas 36 per cent of the cases had edge-to-edge bite and 64 per cent over-bite (52% of slight, and 12% of marked degree).

Chin. The chin was "receding" in 10 Sumus and in 14 Ramas, "medium" in 2 Sumus and 10 Ramas, and "prominent" only in one Rama.

Nose. The nose height amounts on an average to 70.26 per cent of the upper face height in the Sumus and to 69.59 per cent in the Ramas. The breadth of the nose constitutes on an average 27.91 per cent of the bizygomatic breadth in Sumus and 25.42 per cent in Ramas. It can be stated, therefore, that the Ramas have the proportionately smaller nose, both in regard to height and width, but the difference is much greater in regard to the latter.

The Ramas have the narrower nose, not only in relation to the face width but also in proportion to the nose height, as shown by a comparison between the nasal indices in the two races. This index averages 65.96 in the Ramas and 73.76 in the Sumus. The range of variation extends in the former from 57.6 to 75.9 and in the latter from 66.0 to 83.3. These Indians are, therefore, without exception, either leptorrhinic or mesorrhinic, the first being characteristic of the Rama, the second of the Sumu. The average nasal index of the Ramas is rather unusually low for American Indians.

The profile of the nose was straight in 4 Sumus and 20 Ramas and slightly convex in 8 Sumus and 5 Ramas. A perfectly straight nose is therefore the rule for Ramas but rather exceptional in Sumus.

Eyes. The Sumus have an absolutely as well as relatively narrower distance between the inner angles of the eyes than the Ramas. The absolute interocular breadth averages in the former 33.9 mm., in the latter only 33.0 mm. In relation to the bizygomatic breadth, the width between the eyes amounts on an average to 24.08 in the Sumus with a range of variation from 21.1 to 28.2; in the Ramas the average is lower, namely 23.05 and the range of variation extends from 20.0 to 26.4. In a series of American white men the author obtained an average for this index of 23.01 and in a series of adult male negroes an average of 24.81; the Nicaraguan Indians fall in this respect between the whites and negroes. It is of interest here to recall that not only the interorbital septum, but also the nose and the mouth were found to be narrower in the taller Ramas than in the Sumus.

The eye color was noted as "medium brown" only in one Rama (No.

31) as "dark brown" in 13 Ramas and 9 Sumus, and as "very dark brown" in 10 Ramas and 3 Sumus.

A small plica marginalis (epicanthus) was found in one Rama Indian.

Ears. The Sumus have relatively broader ears than the Ramas, the physiognomic ear index in the former averaging 54.09, in the latter 52.64. Both these values are very low, judging by Martin's tabulation of this index in various human races, where it is shown to range from 52.8 in Ainos to 66.2 in Mawamby pygmies. Male Choctow Indians have an ear index of 54.2 (Collins, 1925), male Colorado Indians one of 59.0 (Rivet, quoted by Martin), and the South American Quichua and Machiganga men one of 61.1 and 61.9 respectively (Ferris, 1921). These are sufficient figures to show that the author's Central American series, particularly the Ramas, have relatively narrow ears.

The relative ear size is obtained by expressing the arithmetic mean of the two ear diameters in per mille of the stature. This ratio varies in the Nicaraguan Indians between 27.3 and 34.9; in the Sumus it averages 31.13 and in the Ramas 29.66. The former value is higher than any of the figures given by Hrdlička (1925) for whites.

The ears lay flat against the head in 5 Sumus and 7 Ramas; they were moderately flaring in 7 Sumus and 16 Ramas, and markedly flaring in 2 Ramas. The helix was rolled in for only one-third (the upper one) of its extent in 3 Sumus and 11 Ramas, for two-thirds in 8 Sumus and 14 Ramas, and entirely in only 1 Sumu. The lobule was very small in 8 Sumus and 13 Ramas, of medium size in 2 Sumus and 11 Ramas, and large in 2 Sumus and 1 Rama. Only in 3 of the 12 Sumus and in 2 of the 25 Ramas was the lobule free; in all the others (75% of Sumus and 92% of Ramas) it was completely attached to the head. Martin states that an attached ear lobule is a primitive condition which seems to be most frequent among Mongoloid races. The percentage frequencies for

TABLE 3. PERCENTAGE FREQUENCIES OF SYMMETRY AND ASYMMETRIES AND AVERAGE DIFFERENCES (INCLUDING CASES OF SYMMETRY) BETWEEN MEASUREMENTS ON THE RIGHT AND ON THE LEFT (EXPRESSED IN PERCENTAGE OF SMALLER MEASUREMENT) IN INDIANS (RAMAS AND SUMUS COMBINED) AND WHITES.

Measurement	Race:	Cases:	r.>l.	r.=l.	l.>r.	Aver. % differ.
Foot breadth	Indians	37	54	14	32	3.20
Foot length	Indians	37	49	5	46	1.31
	Whites[4]	500	31	16	53	1.11
Ear breadth	Indians	37	38	14	48	4.97
Ear height	Indians	37	38	19	43	2.79
	Whites	100	33	37	30	1.85

[4]For the measurements on 438 whites of this series the author is indebted to Dr. R. B. Bean.

the attachment of the lobule in various races, quoted by Martin, are all lower than those in the Nicaraguan Indians.

Asymmetries. The measurements on the foot and those on the ear were taken on the right and on the left side in order to gain some idea on the prevalence of asymmetries in Indians. Table 3 summarizes the results and compares them with some of the author's findings from another, as yet unpublished, study on asymmetries in whites. The small number of Indians does not permit any definite conclusions in regard to the question as to which of the two sides is most frequently characterized by the larger measurements. It seems certain, however, that the ears are more asymmetrical than the feet in whites as well as in Indians, and that the breadth measurements show greater asymmetries than the dimensions in length. It will be of interest to learn from future investigations whether the tentative conclusion can be confirmed that Indians possess a greater tendency to asymmetries than whites.

SUMMARY

The following enumeration of the more important observations and measurements may serve as a condensed characterization of these Nicaraguan Indians and at the same time will show those points in which the two tribes differ from each other.

Average condition in:	*Sumus*	*Ramas*
Skin color	No. 22	No. 23 (slightly darker)
Hair color	black in both	
Eye color	dark brown	dark brown to very dark br.
Stature	1582 mm.	1661 mm.
Sitting height	proportionately short in both	
Shoulder width	proportionately broad in both	
Relative arm length	fairly long	rather short
Hand index	above average in both	
Relative lower limb length	relatively long in both	
Foot length	relatively long in both	
Foot index	below average in both	
Relative head size	small for stature	average for stature
Cephalic index	89.5 (very broad heads)	85.9
Morphological face index	84.8 (very narrow faces)	85.2
Breadth of mouth	large (39.5 mm.)	small (36.4 mm.)
Lips	thin	medium thick
Size of nose	relatively large	relatively small
Nasal index	73.8	66.0 (low for Indian)
Nasal profile	slightly convex	straight
Ears	proportionately narrow in both	

Even though more extensive series might eliminate some of the apparent differences between the Ramas and Sumus, the author is convinced that sufficient distinctions would remain to separate the two tribes. In many respects these Indians can be regarded as rather extreme. An average stature of only 158 cm., an average cephalic index of as much as 89.5, a face index of 85.2, a face breadth-head breadth

index of as little as 91.5, a nose index of only 66.0, and an ear index of no more than 52.6 are uncommon among American aborigines. It remains to be seen to what extent these conditions are typical for Central American Indians.

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TABLE OF ABSOLUTE MEASUREMENTS

Number	Stature	Sitting height	Biacromial breadth	Total arm length	Hand length (l.)	Hand breadth (l.)	Foot length (l.)	Foot breadth (l.)	Head length	Head breadth
1	1427	731	349	660	157	70	205	82	161	145
2	1505	794	375	687	157	70	234	88	172	148
3	1537	786	361	716	164	72	237	94	178	150
4	1562	805	363	731	164	79	232	87	174	143
5	1575	809	376	738	175	76	239	91	168	155
6	1576	786	339	750	175	76	241	91	169	163
7	1595	813	377	684	174	83	243	101	170	162
8	1602	825	360	709	172	79	249	102	167	154
9	1615	812	392	723	174	74	236	89	172	159
10	1643	814	387	741	180	80	271	110	178	155
11	1662	824	392	771	172	78	247	98	179	152
12	1680	855	355	790	179	82	271	102	177	160
Average	1581.6	804.5	368.8	725.0	170.3	76.6	242.1	94.6	172.1	153.8
13	1538	778	379	656	162	74	230	99	170	159
14	1545	810	355	664	162	77	220	93	183	156
15	1580	770	355	725	167	75	242	95	176	156
16	1588	802	355	712	173	75	241	94	180	159
17	1596	815	382	737	186	78	248	101	183	153
18	1615	835	402	714	178	84	253	95	182	159
19	1633	821	394	728	172	79	256	99	177	149
20	1647	845	366	721	170	74	237	89	174	154
21	1648	830	399	725	174	73	248	97	178	160
22	1651	830	385	725	182	82	254	96	182	159
23	1652	854	400	729	184	79	242	101	182	155
24	1662	897	399	706	184	80	253	103	176	152
25	1668	842	376	723	181	85	249	106	178	150
26	1669	823	370	709	181	77	260	101	177	154
27	1674	850	382	734	177	81	248	98	176	152
28	1688	834	406	764	187	85	259	103	178	152
29	1695	847	390	765	174	76	252	102	181	153
30	1704	903	409	753	179	86	257	102	183	154
31	1711	860	414	763	189	81	266	104	182	155
32	1713	855	399	777	181	79	254	98	176	153
33	1720	917	389	780	189	85	255	112	184	148
34	1723	845	390	749	188	83	263	110	183	152
35	1727	853	415	778	190	80	270	112	190	167
36	1734	846	381	779	192	82	266	101	184	153
37	1738	854	416	773	198	83	279	105	185	150
Average	1660.8	840.6	388.3	735.6	180.0	79.7	252.1	100.6	180.0	154.6

Absolute measurements of Sumus (above) and Ramas (below).

TABLE OF ABSOLUTE MEASUREMENTS—*Continued*

Number	Head height	Minim. frontal br.	Total face height	Upper face height	Nose height	Bizygomatic breadth	Bigonial breadth	Mouth breadth	Nose breadth	Interocular breadth	Ear height (l.)	Ear breadth (l.)
1	117	105	114	73	56	138	98	52	43	39	56	28
2	124	101	122	75	51	135	110	48	37	31	64	30
3	130	107	121	78	57	141	99	55	41	35	60	32
4	120	106	118	74	53	129	104	49	35	33	63	35
5	129	112	117	76	56	139	103	59	37	36	60	34
6	132	106	123	82	59	150	119	64	45	37	73	37
7	130	107	113	67	48	140	105	55	40	33	66	38
8	136	108	126	81	55	147	105	57	39	33	61	40
9	128	110	123	74	53	150	108	55	40	36	66	31
10	133	108	124	82	51	142	114	61	39	30	68	38
11	126	107	112	73	50	139	106	55	39	33	59	32
12	135	112	119	77	52	140	111	57	37	31	72	40
Average	128.3	107.4	119.3	76.0	53.4	140.8	106.8	55.6	39.3	33.9	64.0	34.6
13	140	109	118	79	57	144	113	51	34	38	59	31
14	133	102	122	77	50	136	105	46	35	35	65	31
15	137	101	122	79	54	132	103	49	35	34	60	34
16	133	100	120	80	55	143	110	51	38	36	61	34
17	125	108	120	81	57	144	110	54	35	32	61	36
18	137	108	119	75	55	144	115	52	35	33	59	35
19	137	106	130	84	57	139	110	50	38	33	63	34
20	125	102	116	79	54	140	112	48	36	32	72	31
21	127	113	130	89	61	149	116	56	36	34	62	32
22	126	106	116	75	54	145	113	53	36	36	66	35
23	128	113	126	80	55	151	115	56	37	31	66	38
24	128	103	120	80	54	143	108	54	39	30	67	33
25	137	104	120	79	54	143	113	51	41	30	63	35
26	126	109	120	81	57	140	114	53	39	34	67	39
27	128	108	113	74	53	143	110	53	35	32	61	31
28	138	104	125	80	54	140	108	45	32	31	67	37
29	142	112	114	75	51	146	115	55	39	35	67	34
30	132	106	127	83	60	142	110	53	36	30	68	33
31	135	119	127	83	60	148	116	55	36	31	64	36
32	139	104	124	82	59	140	106	46	34	33	64	35
33	131	105	125	81	59	142	112	55	38	33	69	31
34	136	105	120	73	50	150	117	55	36	30	63	31
35	139	113	128	82	57	150	116	60	39	36	70	35
36	141	108	117	77	55	142	114	53	35	36	65	32
37	136	109	130	81	53	145	119	51	37	30	66	35
Average	133.4	107.1	122.0	79.6	55.4	143.2	112.0	52.2	36.4	33.0	64.6	33.9

Absolute measurements of Sumus (above) and Ramas (below).

TABLE OF INDICES

Number	$\frac{\text{Sitting height}}{\text{Stature}} \times 100$	$\frac{\text{Total arm length}}{\text{Stature}} \times 100$	$\frac{\text{Hand length}}{\text{Stature}} \times 100$	$\frac{\text{Hand breadth}}{\text{Hand length}} \times 100$	$\frac{\text{Foot length}}{\text{Stature}} \times 100$	$\frac{\text{Foot breadth}}{\text{Foot length}} \times 100$	$\frac{\text{Head module}}{\text{Stature}} \times 100$	$\frac{\text{Head breadth}}{\text{Head length}} \times 100$	$\frac{\text{Head height}}{\text{Head length + breadth}} \times 200$	$\frac{\text{Total face height}}{\text{Bizygomatic breadth}} \times 100$	$\frac{\text{Nose breadth}}{\text{Nose height}} \times 100$	$\frac{\text{Ear breadth}}{\text{Ear height}} \times 100$	$\frac{\text{Ear height + breadth}}{\text{Stature} \times 2} \times 1000$
1	51.2	46.2	11.0	44.6	14.4	40.0	9.9	90.1	76.5	82.6	76.8	50.0	29.4
2	52.7	45.6	10.4	44.6	15.5	37.6	9.8	86.1	77.5	90.4	72.6	46.9	31.2
3	51.1	46.6	10.7	43.9	15.4	39.6	10.0	84.3	79.3	85.8	71.9	53.3	29.9
4	51.5	46.7	10.5	48.1	14.8	37.5	9.4	82.2	75.7	91.5	66.0	55.6	31.3
5	51.3	46.8	11.1	43.4	15.2	38.0	9.6	92.3	79.4	84.2	66.1	56.7	29.8
6	49.8	47.5	11.1	43.4	15.3	37.7	9.8	96.4	79.5	82.0	76.3	50.7	34.9
7	50.9	47.9	10.9	47.7	15.2	41.6	9.7	95.3	78.3	80.7	83.3	57.6	32.6
8	51.4	44.2	10.7	45.9	15.5	41.0	9.5	92.2	84.7	85.7	70.9	65.6	31.5
9	50.3	44.7	10.8	42.5	14.6	37.7	9.5	92.4	77.3	82.0	75.5	47.0	30.0
10	49.5	45.0	10.9	44.4	16.5	40.6	9.4	87.1	79.9	87.3	76.5	55.9	32.2
11	49.5	46.3	10.3	45.3	14.9	39.6	9.2	85.0	76.2	80.6	78.0	54.2	27.4
12	50.8	47.0	10.7	45.8	16.1	37.7	9.3	90.4	80.2	85.0	71.2	55.6	33.3
Average	50.83	46.21	10.76	44.97	15.28	39.05	9.59	89.48	78.71	84.82	73.76	54.09	31.13
13	50.5	42.6	10.5	45.6	15.0	43.0	10.1	93.5	85.1	81.9	59.7	52.5	29.2
14	52.4	43.0	10.5	47.5	14.2	42.3	10.2	85.3	78.5	89.7	70.0	47.7	31.0
15	48.7	45.8	10.6	44.9	15.3	39.2	9.9	88.6	82.5	92.4	64.8	56.7	29.7
16	50.5	44.8	10.9	43.3	15.2	39.0	9.9	88.3	78.5	83.9	69.1	55.7	29.9
17	51.0	46.1	11.6	41.9	15.5	40.7	9.7	83.6	74.4	83.3	61.4	59.0	30.3
18	51.7	44.2	11.0	47.2	15.7	37.5	9.9	87.4	80.3	82.6	63.6	59.3	29.1
19	50.2	44.5	10.5	45.9	15.7	38.6	9.4	84.2	84.0	93.5	66.7	54.0	29.7
20	51.3	43.8	10.3	43.5	14.4	37.5	9.2	88.5	76.2	82.9	66.7	43.1	31.3
21	50.3	44.0	10.5	41.9	15.0	39.1	9.4	89.9	75.2	87.3	59.0	51.6	28.5
22	50.2	43.9	11.0	45.0	15.4	37.8	9.4	87.4	73.9	80.0	66.7	53.0	30.6
23	51.7	44.2	11.1	42.9	14.6	41.7	9.4	85.2	76.0	83.4	67.3	57.6	31.5
24	53.9	42.5	11.1	43.5	15.2	40.7	9.1	86.4	78.1	83.9	72.2	49.3	30.0
25	50.5	43.3	10.8	46.9	14.9	42.6	9.3	84.3	83.5	83.9	75.9	55.6	29.3
26	49.3	42.5	10.8	42.5	15.6	38.8	9.1	87.0	76.2	85.7	68.4	58.2	31.7
27	50.8	43.8	10.6	45.7	14.8	39.5	9.1	86.4	78.1	79.0	66.0	50.8	27.5
28	49.4	45.2	11.1	45.4	15.3	39.8	9.2	85.4	83.6	89.3	59.3	55.2	30.8
29	49.9	45.1	10.3	43.7	14.9	40.5	9.4	84.5	85.0	78.1	76.5	50.8	29.8
30	53.0	44.2	10.5	48.0	15.1	39.7	9.2	84.2	78.4	89.4	60.0	48.5	29.6
31	50.2	44.6	11.0	42.8	15.5	39.1	9.2	85.2	80.1	85.8	60.0	56.3	29.2
32	49.9	45.3	10.6	43.6	14.8	38.5	9.1	86.9	84.5	88.6	57.6	54.7	28.9
33	53.3	45.3	11.0	44.9	14.8	43.9	9.0	80.4	79.9	88.0	64.4	44.9	29.1
34	49.0	43.4	10.9	44.1	15.3	41.8	9.1	83.1	81.2	80.0	72.0	49.2	27.3
35	49.4	45.0	11.0	42.1	15.6	41.5	9.5	87.9	77.9	85.3	68.4	50.0	30.4
36	48.8	44.9	11.1	42.7	15.3	38.0	9.2	83.2	83.7	82.4	63.6	49.2	28.0
37	49.1	44.5	11.4	41.9	16.0	37.7	9.0	81.1	81.2	89.7	69.8	53.0	29.0
Average	50.60	44.26	10.83	44.30	15.16	39.92	9.40	85.92	79.84	85.20	65.96	52.64	29.66

Indices of Sumus (above) and Ramas (below).

REACTIONS OF EIGHT SAN BLAS INDIANS TO PERFORMANCE TESTS

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The eight Indians of the San Blas tribe who were in the United States for about six months with Mr. R. O. Marsh, were given mental tests at their home in Washington, December 1924, by the writer. Three of the group, Cheepu, Marguerite and Olo were "white Indians" (incomplete albinos). The exact age of these three could not be determined, though I judged from physical maturity and other information available that Cheepu was twelve years old and that Marguerite and Olo were between the ages of fourteen and sixteen. Jim and Alice are the parents of Marguerite. Both have typical Indian pigmentation, though both have "whites" in the immediate family. Philip, Alfred and Iqua are adult males of typical Indian pigmentation. Iqua has distant relatives who are "whites" and Alfred has a nephew who is "white." Nothing is known of Philip's family.

In selecting tests for the group it was necessary to choose pure performance tests. Philip and Iqua have worked on the sea and speak broken English. The other members of the group speak practically no English. Ten tests from the Pitner and Paterson scale were selected, namely: The Mare and Foal Test; The Casuist Form Board; The Triangle Test; The Diagonal Test; The Maniken Test; Healey Puzzle "A;" The Feature Profile Test; The Picture Completion Test; and The Cube Test. They were given in the order named. The Thorndyke Mechanical Test was also given to each of the Indians.[1]

[1]The Mare and Foal test consists of a barnyard landscape, with mare and foal in foreground, pasted on a board 1 cm. thick. Seven pieces (being whole or parts of animals) are cut out with a scroll saw and have to be returned to their proper places.

In the Casuist Form board, 12 plain pieces have to be fitted into 4 fairly large holes so as to fill them completely. In the Triangle test 4 exactly similar triangles have to be fitted to one square and one large triangle. In the Diagonal Test 5 pieces of varied form and size have to be fitted into a rectangular area.

The Manikin test consists of 6 pieces cut by means of a scroll saw out of a thin board. The pieces are a torso, a head, 2 arms and 2 legs. The 2 upper and lower appendages are not alike in their line of junction to torso, i. e. the form of the socket.

The Healy Puzzle "A" consists of a frame surrounding a depression 10.3 x 7.9 cm. in size. Into the depression are to be fitted 5 blocks of the same thickness as the frame; three 7.5 x 3 cm., 7.2 x 2.5 cm., 5.1 x 3.4 cm., respectively; and two small pieces each 3.8 x 2.5 cm. Brings out perception of relationship of form.

The Feature Profile Test consists of a profile of the head cut out of a board by means of a scroll saw and with a square (that includes the whole ear) cut out and divided into 4 pieces. The face also is cut up into 3 pieces. These pieces have to be put in their proper position to make a good profile.

In the Picture Completion Test there is a landscape pasted on the 1 cm. thick

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None of the group seemed to grasp the idea of the Picture Completion Test, even after as many as three squares had been placed for them. Several filled the spaces but with no regard for selection. More language is required for the presentation of this test than for any other. Since the reaction of all showed absolutely a lack of comprehension and since the test involves associations which they would not be expected to make, it has been decided not to include the results of this test in the score.

Table A presents the age scores of each individual on each test and also gives the median mental age of each one. We do not present this as absolute but as an indication of the mental ages which they approximate.

TABLE A. INDIVIDUAL AGE-SCORES OBTAINED ON EACH OF NINE PERFORMANCE TESTS BY EIGHT SAN BLAS INDIANS AND THE MEDIAN MENTAL AGE OF EACH INDIVIDUAL; USING METHOD OF PITNER AND PATERSON (1917).

Name	Chronological age	Mare and foal test		Seguin form board	Casuist form board		Triangle test	
		Time	Error		Time	Error	Time	Error
Cheepu	12	9	13.5	6	8	8	10	9.5
Mar	14–16	6	13.5	5	D.N.C.*	D.N.C.*	6	5
Olo	14–16	6	9.5	7	D.N.C.*	D.N.C.*	8	9.5
Jim	adult	7	16	6	D.N.C.*	D.N.C.*	6	7
Alice	adult	8	6	5	D.N.C.*	D.N.C.*	16	16
Philip	adult	7	16	6	7	9	9	13
Alfred	adult	10	13.5	6	6	8	13	14
Iqua	adult	8	16	5	6	7	9	14

Name	Diagonal test		Healey puzzle "A"		Manikin test	Feature profile test	Cube test score	Median mental age
	Time	Error	Time	Moves				
Cheepu	6	7	14	16	5	16	10.5	9.5
Mar	D.N.C.*	D.N.C.*	7	9	5	D.N.C.*	9.5	5
Olo	10	9	13	16	12.5	13	16	9.5
Jim	7	12	7	9	12.5	D.N.C.*	6	7
Alice	6	6	7	8	5	10	4	6
Philip	9	10	11	16	6	16	12	9.5
Alfred	10	13	8	10	5	D.N.C.*	6	8
Iqua	9	14	11	16	12.5	D.N.C.*	10	9.5

*Did not complete.

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board, showing 11 persons and 1 chicken doing something. The principal object of the attention of each person has been cut out in 10 small squares and these squares mixed with about 40 other similar squares (most of which have pictures of objects that are not germane to the main picture) have to be replaced in the proper holes.

In the Cube test there are 5 similar blocks, 4 placed at fixed distances apart on the table and numbered 1 to 4 from left to right; the fifth is used by the examiner to tap the blocks in a certain definite order and at the rate of one per second. The fifth block is given to the examinee who is told to do the same as he has just seen done. The order of the tapping of the blocks is varied in each of the 12 trials made: 1234, 12343, 12342, 1342, etc. This tests ability to keep an operation in mind and reproduce it.

The Thorndike Mechanical Test consists of a graded series of operations with tools, etc. Examples are: a nut to put on a bolt, the lower jaw of a wrench to be fitted on, the parts of a simple "rim" lock to be put in place.

I will discuss rather briefly the individual reactions to the separate tests.

The Mare and Foal Test and The Seguin Form Board were easily completed by all with very few false judgments. The length of time required in each case was more than the average. The Casuist Form Board presented the most difficult problem on the whole, and half of the group did not complete it. Each of them repeatedly tried the same wrong combinations. Cheepu completed the test rather easily. Marguerite worked for seven and one-half minutes and had only completed one small portion. Her method was haphazard and lacked reasoning. Olo worked aimlessly and by chance solved one section. This seemed to give him the clue and he quickly completed the test. His time was up, however, and his solution did not count. Jim had no system about his work and did not complete the test. He had a childish manner of asking questions and seeking approval. Alice gave the quickest and best solution of the group. Philip worked for four and one-half minutes and refused to continue. Alfred and Iqua made the same mistakes repeatedly but by chance completed the test.

In the Triangle Test, only Jim seemed to grasp the idea of relationship between the pieces and the spaces and the relationship of the pieces to each other. Other members of the group gave a trial and error solution. The Diagonal test was rather well reasoned out by all except Marguerite and Alice. Marguerite placed one block wrong and this threw out the entire solution. Alice solved it altogether by a trial and error method and it was only by chance that she hit upon the solution.

In the Healy Puzzle "A," Marguerite and Alice again repeatedly tried the same wrong combinations with no profit from experience and seemed to reach the solution by chance after many trials. Jim completed the test with a large number of moves and much encouragement on the part of the examiner to continue. Cheepu, Olo, Philip and Iqua made comparatively good scores. Olo seemed to carry over elements of the method from the preceding test.

All of the Indians seemed to get the idea of the man in the Manikin Test though none of them noted the shape of sockets in relation to the shape of the arms. The markings on the hands and feet did not mean anything to them. Olo, Jim and Alfred placed one pair of appendages in the wrong sockets, by chance placed the others right, noted the difference and changed the first ones. No one placed legs in arm sockets or vice versa.

The idea of following a diagram in the Feature Profile Test seemed

lost to the Indians as a group. Cheepu gave a quick and accurate solution, immediately recognizing the human head. Marguerite placed the ear pieces with no regard to lines. After many trials she arranged the profile with the idea of having the pieces fit and not recognizing the human head. Olo and Alice arranged the ear pieces with no regard to lines. They then arranged the profile. This seemed to give them the idea that the diagram meant something, so they came back and arranged the ear pieces correctly. Jim had no regard for ear lines. Philip gave a perfect solution in a rather short time. Alfred and Iqua did not recognize the human head. After trial and errors they arranged the profile with the idea of making the pieces fit. No regard was shown for the ear diagram.

Olo gave a particularly good reaction to the Cube Test, repeating ten out of twelve combinations. His mind seemed alert and he appeared to have a splendid retentive memory. Alice repeated the first combination. She did not grasp the idea that a new combination was given each time and she continued to repeat the first combination after each one given by the examiner. Philip repeated seven out of twelve combinations. As a group, they were not able to follow the more complicated combinations.

CONCLUSIONS

As will be noted from Table A, the median mental ages of the members of the group are low. Cheepu and Olo who are "white" Indians ran highest in comparison with chronological age, while Marguerite, the "white" Indian girl had the lowest median mental age. Her mother, the only other woman of the group, had the second lowest median mental age.

Reason and judgment seemed poorly developed in them. Trial and error and chance appeared to be the outstanding methods of solution. On the whole they did not see the size and shape of the loose parts in relation to the size and shape of the spaces. They did not profit from experience and would repeatedly try the same combinations which were obviously wrong.

As a group, the examiner had no difficulty in gaining and holding their attention. The tests were given under circumstances which permitted only a minimum degree of distraction. The novelty of the tests appealed to them. Cooperation was good in practically every case. The male members of the group showed a marked desire to excell and had a childish manner of continually asking how their score compared

with another. Jim and Alice, the elder members of the group, were rather reticent in attacking the materials. They were slightly self-conscious; while this element was entirely missing from the other members of the group.

Perseverence was a rather marked trait in them. Several times it was necessary to encourage them to proceed, but, on the whole, they stuck to a problem as if riveted to it. They did this in a rather dumb sort of way, trying over and over solutions which had failed. They recognized perfection and seldom offered a solution which was not true.

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CORRELATION OF LENGTH AND BREADTH OF HEAD IN AMERICAN NEGROES

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The problem of homogeneity or heterogeneity of a population is one to which too small attention has been paid by anthropologists in the course of their analyses of existing populations. It is, however, one which sooner or later must be studied in detail, and it is believed that research into the processes which make for homogeneity or heterogeneity, quite aside from racial background, will give ultimately a far clearer idea of the developmental processes which human groups undergo than will be obtained from studies exclusively designed to determine racial purity. The extent to which all human groups have intermingled is too often overlooked, to the resulting confusion of the findings, and it would seem that the general principle of strict induction from existing populations is preferable to analyses of populations into racial types.

The variability of the American Negro, and a study of the homogeneity of this group, has already been approached by the writer in two papers.[1] In these, a statistical analysis of the variability of the averages of fraternities of Negro children from New York City was utilised, and the results were such as seemed to justify the view that the American Negro has become homogeneous to a surprising degree,—surprising, that is, when the amount of mixture he represents is considered. At the same time, it was pointed out that homogeneity and racial purity are not to be confused, but that the former is the result of inbreeding of a group, the ancestry of which may be as varied ethnically as is that of the American Negro, or that of the Rehobother Bastards of South Africa. Of course, homogeneity does not preclude unity of racial origin in a human group, to a greater or less extent, for there can be the same inbreeding leading to homogeneity among the descendants of persons of one racial type, such as has been demonstrated for the Tennessee mountaineers.[2]

It has been shown by Boas[3] that the correlation of the length and breadth of head offers another indication of the extent to which a population may be regarded as homogeneous. Commenting on the coeffi-

[1] *Proc. XXIst Int. Cong. Amer.* The Hague, August, 1924. *J. Am. Stat. Ass.*,1925, XX, 380–389.

[2] Isabel Gordon, Reduction of Variability in an Inbred Population (MS), *Doctoral Diss.*, Columbia University, 1925.

[3] Franz Boas, The Cephalic Index, American Anthropologist (n. s.), vol. 1, (1899), pp. 448–461.

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cients of correlation which he presents Boas remarks, "It appears . . . that the degree of correlation between length and breadth of the head is very slight, and that its values differ considerably among the various races. . . . The coefficient of correlation in the Parisians, for instance, is exceedingly low. . . . The most plausible explanation of this phenomenon lies in the effect of mixture of types upon the coefficient of correlation. . . . I think this effect of mixture is a sufficient explanation of the low value of the coefficient of correlation for Paris, where we find a very heterogeneous population. . . ."[4] The figures for the populations for which the coefficients of correlation between length and breadth of head have been computed will be given below; it will be well, however, to consider first the data from which these figures are drawn for the American Negro groups studied, and the variabilities which are involved in the coefficients of correlation later computed from them.

The present paper is a result of a portion of the measurements in a general study of Variability under Racial Crossing, with special reference to the American Negro-White population. The data represented in it were gathered in New York City and Washington, D. C. From the former city come the 1211 boys of Public School 89, and 63 male adults, the data for which are tabulated with those for the 477 male adults measured at Howard University in Washington.[5] The measurements were made with spreading calipers of the type designed by Martin, and

TABLE 1. AGE MEANS FOR LENGTH AND BREADTH OF HEAD, NEW YORK CITY COLORED BOYS.

		Length of head (mm.)		Breadth of head (mm.)	
Age	No.	Mean	$\pm\sigma$	Mean	$\pm\sigma$
5–6	22	174.61	±6.43	139.46	±4.17
6–7	55	178.35	±6.46	140.90	±5.87
7–8	101	178.49	±6.46	139.62	±5.00
8–9	124	179.67	±6.18	141.56	±4.93
9–10	130	181.49	±5.52	141.75	±5.26
10–11	135	181.58	±6.67	142.19	±5.39
11–12	140	183.75	±5.71	142.85	±4.51
12–13	126	184.40	±6.42	143.66	±4.83
13–14	140	186.18	±5.76	144.03	±5.71
14–15	117	187.98	±6.48	146.48	±4.77
15–16	81	190.06	±6.02	147.19	±5.44
16–17	30	190.30	±6.03	146.63	±4.69
17–18	12	190.66	——	147.66	——

[4] *l. c.*, pp. 453–455.

[5] This study is being carried on by the writer as Fellow of the Board of Fellowships in the Biological Sciences, National Research Council, and the data gathered at Howard University were taken with the assistance of a grant from the Committee on Human Migrations of the National Research Council. The writer wishes to express his thanks to Dr. Jacob M. Ross, Principal of Public School 89, Manhattan, and his teaching staff, for their cooperation while measurements were being taken there, and to the President and Faculty of Howard University for their permission to work there, and for their numerous aids and hearty cooperation.

consist of the maximum glabellar length of the head, and the maximum width, the indices being computed from these two figures. In the case of the New York boys, the factor of growth has had to be reckoned with, and the computation for means and standard deviations were first made within age groups, the results of which are shown in Table 1. For the age means for cephalic index for these boys, the reader is referred to the writer's paper presented at the XXIst Congress of Americanists, already referred to.

The male adult material gathered at Howard University and in New

Table 2. Distribution Table of Length and Breadth of Head and Cephalic Index for 539 Male Negro Adults.

Length of head		Width of head		Cephalic index	
Mm.	No.	Mm.	No.	Index	No.
179	2				
180	—				
181	—	131	1		
182	6	132	—	62.5	1
183	7	133	1	63.5	—
184	7	134	2	64.5	1
185	6	135	—	65.5	—
186	10	136	1	66.5	1
187	13	137	1	67.5	—
188	15	138	2	68.5	1
189	15	139	5	69.5	7
190	10	140	2	70.5	6
191	25	141	2	71.5	14
192	9	142	10	72.5	29
193	35	143	11	73.5	30
194	29	144	21	74.5	47
195	30	145	8	75.5	75
196	31	146	25	76.5	67
197	31	147	33	77.5	55
198	36	148	24	78.5	66
199	33	149	47	79.6	39
200	18	150	28	80.5	38
201	29	151	28	81.5	21
202	20	152	49	82.5	12
203	36	153	58	83.5	12
204	16	154	34	84.5	8
205	15	155	15	85.5	4
206	14	156	32	86.5	2
207	10	157	21	87.5	1
208	10	158	25	88.5	1
209	8	159	15	89.5	—
210	5	160	6	90.5	1
211	1	161	8		
212	1	162	5		
213	1	163	3		
214	2	164	5		
215	1	165	4		
216	1	166	3		
217	—	167	2		
218	1	168	1		
		169	1		

York City were not arranged by age, as the individuals are from 17 years of age up, ranging mainly about the decade 17–27. The data as tabulated, for length and breadth of head and cephalic index are shown in Table 2.

It was felt, however, that before the Public School data could be utilised for comparative purposes, corrections should be made for age changes, and therefore the figures for all ages were lumped and aveiaged, with the following results, assuming sigma as constant for each year, which is practically the case, as can be seen from the table.

	Sigma
Length of head	±7.24
Breadth of head	±5.57
Cephalic Index	±3.51

However, the standard deviation, computed from data thus thrown together cannot be utilised in this fashion, since the factor of growth makes for heterogeneous data and overlapping of the distributions: this was corrected by the formula

$$\sigma \text{ corr} = \sqrt{\sigma^2 - \frac{\Sigma nd^2}{N}}$$

where σ^2 is the mean square variability of the entire group, uncorrected, n the number of cases in each age group, d the deviation of the mean of each age group from the mean for the total series, and N the total number of cases. The results, therefore, were

Length of head	±6.15
Breadth of head	±5.11
Cephalic Index	±3.47

It is these results which may be compared with those for the adult Negro group from Howard University and New York City of 539 individuals:

	Mean	$\pm\sigma$
Length of head	196.98	±6.77
Breadth of head	151.58	±5.74
Cephalic Index	77.05	±3.49

We find a close correspondence between the standard deviations for both traits and for the cephalic index, and these correspondences, when tested statistically, are found to be due not to chance sampling, but are significant. The means for absolute length and breadth are, of course, not available for comparison, because of the factor of growth involved in the New York boys' series, which tends materially to lower them.

If we compare the mean square variability of the cephalic index of the individuals studied here with the data gathered for numerous other populations, which are given in Table 3, we find that the variability is less than that for the skeletal collections of Western Reserve University, both Negro and White, than for the modern French inhabitants

TABLE 3. COMPARATIVE LENGTHS, BREADTHS, AND CEPHALIC INDICES OF VARIOUS POPULATIONS (MEANS AND STANDARD DEVIATIONS).

Population	No.	Length (mm.)	Breadth (mm.)	Index
New York Negro boys	1211	(183.44)±6.15	(143.12)±5.11	78.08±3.47
Howard Univ. and N. Y. male adult Negroes	539	196.98±6.77	151.58±5.74	77.05±3.49
W. R. U. White[1]	167	181.42±8.19	144.28±5.67	*80.69±4.74
W. R. U. Negro[1]	87	186.20±6.51	139.30±5.66	*75.89±3.13
Oxford Students[2]	959	196.05±6.23	152.84±4.92	78.02±2.92
English Criminals[2]	3000	191.66±6.05	150.44±5.01	77.23±2.74
Cambridge men[3]	1000	193.51±6.16	153.96±5.05	78.33±2.90
Naqada skulls[4]	134	185.13±5.75	134.87±4.60	*73.99±2.80
Batatela[5]	50	177.87±7.05	138.52±5.00	*78.99±2.58
Gaboon (1864)[5]	50	179.48±5.61	135.48±3.38	*76.48±2.77
Whitechapel English[6]	137	189.06±6.27	140.67±5.28	*75.34±3.26
Cairo-born males[7]	802	190.52±5.90	144.45±4.67	75.82±2.91
Aino (Koganai)[8]	87	185.82±5.94	141.23±3.90	*77.50±2.39
Germans (Ranke)[8]	100	180.58±6.09	150.47±5.85	*84.30±3.50
Parisians (Broca)[9]	?	181.85±5.94	144.93±5.21	*80.82±3.79
French peasants[9]	57	179.93±6.30	143.51±5.42	*80.78±3.84
Tenerife males[10]	245–9	185.85±5.35	142.11±4.95	*76.99±2.30
Samoan males[11]	68	190.60±5.69	154.80±4.46	81.30±3.53

*An addition of 1% has been made to the mean indices marked thus since they are cranial populations, so that comparison with series of living may readily be made. Cf. R. Martin, Lehrb. d. Anthrop., 421.

[1]T. Wingate Todd, Cranial Capacity and Linear Dimensions in White and Negro. *Am. J. Phys. Anth.*, 1923, vi, 97 ff.

[2]E. Shuster, First Results from the Oxford Anthropological Laboratories. *Biometrika*, 1911–13, viii, 40 ff.

[3]W. R. Macdonnell, On Criminal Anthropometry and the Identification of Criminals. *Biometrika*, 1901–2, i, 177 ff.

[4]Fawcett and Lee, A Second Study of the Variation and Correlation of the Human Skull. *Biometrika*, 1901–2, i, 408 ff.

[5]R. Crewdson Bennington, A Study of the Negro Skull. *Biometrika*, 1911–12, viii, 292 ff.

[6]W. R. Macdonnell, A Study of the Variation and the Correlation of the Human Skull. *Biometrika*, 1904, iii, 191 ff.

[7]Myer M. Orensteen, Correlation of Anthropometrical Measurements in Cairo-born Natives. *Biometrika*, 1915–17, xi, 67 ff.

[8]Lee and Pearson, Data for the Problem of the Evolution in Man. VI. *Phil. Trans. Roy. Soc.*, "A", cxcvi, 225 ff.

[9]Karl Pearson, Mathematical Contribution to the Theory of Evolution. *Phil. Trans. Roy. Soc.*, "A", 1896, clxxxvii, 253 ff.

[10]E. A. Hooton, The Ancient Inhabitants of the Canary Islands. *Harvard Afr. Studies*, 1925, vii, 89, 91, 96.

[11]L. R. Sullivan, A Contribution to Soman Somatology. *Mem. Bernice Pauahi Bishop Mus.*, 1921, viii, no. 2.

and for French peasants, and than for Samoan males. On the other hand, it is greater than the figures for the various groups of English studied, both living and cranial collections, and more than the variation

for most of the primitive and prehistoric groups represented, such as the Egyptian Naqada skulls, the Batatela and Gaboon crania, the Aino and the Cairo-born natives, and the Tenerife male crania collected by Hooton, while the same variability, approximately, is to be seen between these Negroes and the 100 Germans measured by Ranke. Altho the figures for the means for absolute length and breadth are included in the table, as well as the variabilities, the former cannot be used in making comparisons, since many of them represent cranial collections, the others being measurements on the living; and for the further reason that comparison of indices is more desirable, since the ratios represented are not so easily affected by differences between measurements on the living and on crania. The inclusion of all the results given is made, however, because they are necessary in the computation of the coefficients of correlation, the mean indices from cranial series being increased by 1%. Particular attention should be paid to the lowness of the standard deviations for all three traits for both Negro groups studied by the writer and for the Negro crania in the Western Reserve collection, when these are compared with the similar variabilities for the Whites in the Western Reserve collection. These last represent an unselected group (except insofar as there is an economic selection at work) and the differences between the Negro groups and the figure for the White group are highly significant if the relative homogeneities are considered.

The comparison of standard deviations for length, breadth, and cephalic index is of interest also in the light of the theories of heredity which are prevalent today. If Mendelian segregation of traits were operative, then the variability of the American Negro group, being of mixed racial origin, should be greater than that of every population which has contributed to its ancestry. If head length be considered first, it is seen that all three samples of the American Negroes are less variable than American Whites, than the Batatela, but more so than the English. For breadth, the American Whites are about the same variability as the American Negroes in the W. R. U. collection but greater than any of the other populations with the exception of the Germans, altho the difference here is not great between any of the populations. The variability of cephalic index has already been discussed, but for convenience it may again be noted that the highest variability of the entire series is that of the W. R. U. White population, while the Germans, French peasants, and Whitechapel English series fall either well within the range of variability of the American Negro

groups or are larger in this respect than they are. The operation of the Mendelian principle, if it is operative, cannot, it goes without saying, be observed adequately in any rough fashion such as this since actual parent-and-child material is most desirable. But on the other hand, the principles which have been laid down are so broad that if they were working at all, certain statistical results should be observable, as explained above. And these do not appear. It seems to argue a blending of type rather than a segregation, but the entire problem must be laid aside for further and more detailed consideration, both from other aspects of these data, and thru the measurement of actual family groups, both of which, it is hoped, will be done.[6]

Since these groups of American Negroes represent descent from West African and European groups in the main (altho there is also an appreciable amount of American Indian ancestry present, it is believed) it is of interest to compare the means for cephalic index for them with those for the populations allied to them. Thus, they are seen to be quite near the figure for the English group, as might be expected, since there is undoubtedly, thru the White ancestry, much English blood represented in these Negroes. On the other hand, this comparison does not hold if we use the figure for the Western Reserve Negroes. The closeness to the Batatela mean index would be quite striking if it were not contrasted by the difference between the American Negro and the Gaboon indices. Comparisons on the basis of one trait or one index are, in the main, unsafe, and therefore there will be no attempt to draw relationships on the basis of the figures given in this paper.

The computation of the coefficient of correlation between length and breadth of the head may be carried out in two ways, both of which are represented in this paper. The first is that of the Pearson product-moment formula, and the correlation between the two traits for the New York Negro children was performed in this way, there being used, because of the complicating growth factor, the deviations of the individual measurements from the respective age means rather than the raw data. However, Pearson has given a formula[7] by which this correlation may be carried out with less computation, an important matter in time-saving. This formula employs the coefficients of variation of the length and breadth of the head and of the cephalic index,

[6]Boas (in The Head-Forms of the Italians as Influenced by Heredity and Environment. Amer. Anth., (n. s.) vol. XV, 1913, pp. 163–188) has shown that the Central Italians, who are very mixed, have higher variability than either the north or south Italians. The fact that African and White indices are so close, however, makes the applicability of this study to the present one difficult.

[7]Karl Pearson, op. cit., pp. 279–80.

$$V \text{ equalling } \frac{100 \text{ sigma}}{\text{Mean}}$$

in the formula

$$r = \frac{V_e^2 + V_b^2 - V_i^2}{2V_eV_b}$$

where r is the coefficient of correlation, V_l the coefficient of variation for length of head, V_b that for the width, and V_i that for the cephalic index. To test the utilisability of the formula, it was used after the coefficient of correlation had been computed on the same data for New York boys by the long method, and the two results are

r (by the product-moment method) $= +.201$

r (by coefficient of variability method) $= +.216$

It will be seen that tho the latter tends to change the coefficient of

Table 4. Coefficients of Correlation between Length and Breadth of Head for Various Populations[1]

No.	Population	Coefficient of correlation (r)
245–9	Tenerife males (Hooton)	+.586
50	Batatela (Bennington)	+.586
47	Male adult Eskimo skulls[2]	+.47
87	Aino (Koganai—Lee and Pearson)	+.4316
3000	English Criminals (Macdonnell)	+.4016
87	W. R. U. Negro males (Todd)	+.3789
1000	Cambridge men (Macdonnell)	+.3448
134	Naqada (Fawcett and Lee)	+.344
—	Australians[3]	+.313
212	University of Aberdeen students[4]	+.3007
100	Germans (Ranke—Lee and Pearson)	+.2861
137	Whitechapel English (Macdonnell)	+.280
—	Ancient Egyptians (Flinders-Petrie)[5]	+.2705
802	Cairo-born natives (Ornsteen)	+.244
243	Sioux Living Males[2]	+.24
539	*Howard Univ. and N. Y. C. Adult Male Negroes*	*+.216*
1211	*New York Negro children*	*+.201*
50	Gaboon, 1864 (Bennington)	+.187
959	Oxford students (Shuster)	+.143
—	Bagdi caste of Bengal[2]	+.13
57	Modern French Peasants (Pearson)	+.1263
—	Baden male skulls[2]	+.09
—	Adult male Indians, British Columbia	+.08
—	Modern French Parisians (Pearson)	+.0474
—	Adult male Sushwap Indians[2]	+.04
167	W. R. U. White males (Todd)	—.0045
68	Samoan males (Sullivan)	—.058

[1]The coefficients for populations for which references have been given in Table 3 may be looked up in the original publications by reference to the titles appended to that table. Such papers only as were not cited in Table 3 are noted here.

[2]F. Boas, The Cephalic Index, loc. cit., p. 453.

[3]From table in R. Martin, Lehrb. d. Anthrop., p. 706.

[4]Reid and Mulligan, Communication from the Anthropological Laboratory of the University of Aberdeen. *J. Roy. Anthrop. Inst.*, 1925, liv, 287 ff. The figure given here is for the 17-year-old group. It is lower for the other three groups which were studied in this paper.

[5]Karl Pearson, *Phil. Trans. Roy. Soc.*, clxxxvi, 280.

correlation somewhat, there is not a serious difference, and therefore both methods are represented without separate designation in the following Table 4.

In surveying the coefficients of correlation for the populations under consideration, it will be seen that the Negro populations studied in America are relatively homogeneous. The correlations for the three figures given for American Negro groups,—Western Reserve crania, the New York boys and the Howard University data,—are strikingly higher than the extremely low correlation for the Western Reserve White crania. It is to be regretted that no available data were at hand from which correlations for other American White representative populations might have been computed, as this would throw further light on the relative homogeneities. However, it seems likely, from the comparison made, that the American Negro is more homogeneous than the White population of this country, taken at large. That the correlation computed here seems to be an indication of homogeneity would seem to show in a consideration of the other populations represented in Table 4. The higher figures represent populations which one might expect to show relatively large homogeneity of type,—the inhabitants of Tenerife, the Batatela, a Congo tribe, the Eskimo, the Aino, various groups of English, the Naqada crania, and the like. On the other hand, at the lower end of the scale we find the Parisians, the mixed Indians of British Columbia, the inhabitants of Gaboon, where there is much mingling, and others. It is not assumed that the list of relative degrees of correlation gives an adequate statement of homogeneity nor can it be relied on to show of itself the extent to which this exists or not. Because, if the correlations were indicators of this, we should not find that the coefficient for the Oxford students and for the Samoans would be so low, since the first, at least, should be as homogeneous as the other English groups studied. It is quite possible that if we had two traits always paired and thus inherited, the result of crossing would be a high correlation, even tho there were heterogeneity; however, it is not without significance that we find the American Negroes so relatively high in the list in view of the comparative variabilities of Table 3 and their standing in it.

If it is true, then, that the American Negro is tending toward a homogeneity of type, it is well to inquire into the cause of this, and to see whether there may be observed any socially selective factor operative to bring about this consolidation of type. If we examine into the case historically, we find that the amount of primary crossing which has

occurred between Whites and Negroes has materially lessened since the Civil War. From the 539 genealogies collected in the course of this study from the adults measured, there were only two the writers of which claimed to be primary crosses. While it is possible that this is far too low a proportion, the fact that there is today social pressure on the Negro as well as on the White side against relations with members of the other race would tend to naturally lower the amount of direct crossing. At the same time, the crossing which has taken place is making itself felt in the Negro population thru the intermarriage of the earlier mixed individuals and their descendants with those who represent no mixture, and the percentage of pure Negroes, it is believed, is being steadily lessened. Indeed, only 20% of the total population represented in these genealogies gave themselves as without some mixture, altho this figure may be somewhat low due to the fact that a majority of these genealogies come from University students.

However, if the above phenomena be granted, there is the further problem of the mechanism of selection which is working to bring the lighter and darker elements among the Negro population together, and thus make for the consolidation of type which seems to be foreshadowed. It was felt that a clue might be obtained thru a consideration of the invidious nature of color distinctions,—lightness being favored, thus causing the dark men to seek the lighter women as wives, while the lighter women marry the darker men because of the advantageous position in the match afforded by their color. A test of this was made with 380 of the Howard students who were measured, and they were asked, each in turn "Who is the lighter, your father or your mother?" The replies, when tabulated, were enlightening. There are, of course, three possible answers; father lighter, mother lighter, and parents about the same. The results are as follows: Father lighter, 115 (29%); same color, 50 (13%); mother lighter, 215 (58%).

This represents, of course, a definite trend, altho it is not claimed that it is more than just that. At the same time, it means that there is something of a consolidation of type occurring among the American Negro population, which would easily account for the relatively low variability which traits show, and for the relatively high figures which the computations of coefficients of correlation for American Negro groups show.

In summary, therefore, we may say that the conclusions from the study described in this paper are as follows:

1. The study of the problem of homogeneity of existing types should constitute an excellent means of determining the processes of changes among human groups.

2. The cephalic index alone cannot be utilised as criterion for relating the American Negro generically to any of the other groups represented in the paper.

3. The variability of the cephalic index seems to bear out the hypothesis of relative homogeneity of the American Negro population.

4. This is further borne out by the computed coefficients of correlation between length and breadth of head for the groups studied, when this is taken in connection with the result mentioned immediately above.

5. This consolidation of type foreshadowed by the figures resulting from such analyses of the American Negro might be accounted for by social selection on the basis of color.

6. As compared to other populations, the variabilities of head length, head breadth, and cephalic index are not sufficiently high to allow us to see the operation of Mendelian principles of heredity, but rather to question whether this result might have been obtained if they had been operative.

LITERATURE[1]

GENERAL; ANATOMY; ANTHROPOLOGY; EVOLUTION

O INSTITUTO DE ANATOMIA: SÚMULA DOS TRABAJOS DE INVESTIGACAO (1911–1925). I Centenario da Faculdade de Medicina do Porto 1825–1925. 8°, Porto, 1925.

The small but well printed volume brings the titles of and briefly comments on the scientific contributions of the Anatomical Institute of Porto from 1911 to 1925. Of the 130 titles of papers, memoirs, etc. a large majority are of direct anthropological interest.

FRANKFURTS ANTEIL AN DER VERBREITUNG ANATOMISCHER KENNTNISSE IM XVI BIS XVIII JAHRHUNDERT. EIN BEITRAG ZUR URGESCHICHTE DER FRANKFURTER HOCHSCHULE. By Wegner (Richard N.)—*Frankfurter Gelehrte Reden u. Abhandlungen*, 1925, V, 39 pp., 10 illustr's.

A valuable and well printed as well as illustrated contribution to the history of anatomical research in Frankfurt a.M. in the XVI–XVIII centuries. In the old bibliography it is interesting to find, under the date 1607, Casmannus' "Anthropologia, hoc est, fabrica humani corporis methodice descripta."

(TOPOGRAPHICAL ANATOMY. By Karel Weigner. In Czech). Part IV, Pelvis, 1922, 8°, 883–1182; Part V, The Extremities, 1925, 1183–1536. Collective Bibliography and Index.

These are the terminal two parts of a work which takes an honorable place with the best in this line. There are in the five parts which constitute the whole work nearly 700 excellent illustrations. The work has been written for the medical man and the surgeon, but in its localizations, illustrations, and numerous references to variation of parts, it is also of interest to physical anthropology.

BETRACHTUNGEN ÜBER DEN TYPUS DES MENSCHEN. By Eickstedt (E. D. v.)—*Umschau*, 1924, 446–453.

A nice popular sketch, but too short, of our more recent knowledge and views in regard to races and constitutional types of man. Occupation, diet, etc. exert, in the author's opinion, a marked influence on the human body, and partly determine the "type." In race mixtures it is often impossible to diagnose a constitutional type, since the latter may have become altered through the inheritance of some racial characters.

A. H. SCHULTZ

ELEMENTS OF SURFACE ANATOMY. By Thompson (I. Maclaren)—Edinburgh, small 8°, 1925 (E. and S. Livingstone, 5s.6d).

This is a good and may eventually in further editions become an excellent little book which, while written primarily for the student of

[1]All unsigned abstracts and reviews are by the Editor.

surgery, is of value and may be made very useful also to students in physical anthropology. Its "fundamental aim is the visualisation of the structures which lie beneath the skin and are hidden by it." It is to teach the student to see clearly where the eye cannot penetrate, *i.e.*, the structures under the skin. It is a study of landmarks and localization. It utilizes some of the landmarks of anthropology. In future editions, however, it would be well to define these landmarks in the terms of the International Agreements (*v.* Hrdlička, "Anthropometry" 8°, Phila., Wistar Inst., 1920) and to call attention to the range of variation in all features and locations.

THE RECAPITULATION THEORY. By MacBride (E. W.)—*Sci. Prog.*, Jan. 1926, XX, No. 79, 461–474.

"The so-called biogenetic law of Haeckel, that the developing organism in its growth from the egg to the adult stage "recapitulates" the past history of the race, was one of the most fascinating additions to the theory of evolution which was made during the nineteenth century. . . . There are three sources of evidence for the ancestry of existing forms, viz. (1) the comparative study of allied species, (2) the study of fossils, and (3) the study of development. . . . Every life history represents a blurred and partly falsified ancestral record; and just as the historian extracts the truth from ancient mutilated records disfigured by later interpolations, by stressing the points on which they agree and discounting those in which they differ, so must the comparative embryologist proceed and only on the basis of a *comparative embryology* can any reliable record of ancestral history be founded." But "what is recapitulated is not ancestral structure as such, but ancestral habits or, perhaps we may more wisely say, an ancestral physiological condition—and this recapitulation or recall we have compared to ancestral memory. Just as no memory image however vivid, retains all the details of the original sensorial presentation, so the structure of no ancestral stage is recorded in all its details. . . Evolution has been slow, functional and continuous." There is "a growing body of evidence that the effects of the habits of one generation are handed on to the next, and in this principle we find not only the key to the explanation of the recapitulatory principle in life-history, but to that of the evolutionary process in general."

(THE THEORY OF CONSTITUTIONALISM AND CONTEMPORANEOUS VIEWS ABOUT THE NORMAL STRUCTURE OF THE HUMAN BODY. In Czech, French Abstract). By Loth (Edward)—*Anthropologie*, Prague, 1924, II, 87–97.

The author properly points out that the modern notions of constitutionalism often repose on imperfectly known or understood morphological facts, and gives a series of illustrations of variations and racial differences (in facial musculature, lumbo-sacral vertebrae, spine, sternum, ribs etc.), which have little if any relation to constitution. The "constitutionalists" should exercise more care in interpreting physical characters and deviations.

THE DAWN OF MANKIND. By Whitnall (Harold Orville)—8°, 1924, xv + 278, 23 illustr's and map. (Boston, Richard G. Badger).

In presenting this book on ancient man "the author claims but little originality. The subject matter has been gathered through wide reading and correspondence. It is an attempt to put together in a small volume the outstanding features of man's long pre-history, and merge them into a connected narrative." The Contents are: The Races of Man; The Dawn of History; Geology and Pre-History; Geography and Culture Stages; Two Types of Ancient Man and Their Times; The Earliest Englishmen; Ancient Habits and Habitats; The Neanderthals and Their Kin; Cro-Magnon Man and his Contemporaries; the Art and Men of the Later Palaeolithic; The Golden Age of Palaeolithic Man; the End of the Old Stone Age; the New Stone Age in Europe; and the New Stone Age in Asia.

The book is readable and on the whole represents a praiseworthy effort which will aid, in connection with other treatises on the subject, to generalize information on man's natural and earlier cultural history. If in spots it fails to please the expert it is only because the author utilizes and builds upon information outside of the scope of his critical possibilities. It is disappointing to find in a book of this nature quotations from Madison Grant.

An interesting item of his own views is the author's opinion that "when more exact knowledge of the inter-glacial times is available, the prevailing idea as to their length will be greatly modified, and that these intervals will be reduced 25 or 30 per cent" (p. 272). This rather agrees with the most recent views of Sir Arthur Keith, and is a subject that is in urgent need of further intensive studies.

EVOLUTION IN THE LIGHT OF MODERN KNOWLEDGE.—London, 1925 (Blackie and Son, Ltd.).

A valuable collective work by well-known men of science representing every branch of knowledge and thought which deals with or is more closely affected by Evolution. It comprises the following sections: Cosmogony, by James A. Jeans, pp. 1–30; The Evolution of the Earth as a Planet, by Harold Jeffreys, 31–58; Geology, by William W. Watts, 59–106; Biology, by Conwy Lloyd Morgan, 107–162; Botany, by Frederick O. Bower, 163–210; Zoology, by Ernest W. MacBride, 211–262; Physiology, by Marcus S. Pembrey, 263–286; Anthropology, by G. Elliot Smith, 287–320; Mental Evolution, by William M'Dougall, 321–354; Physics and Chemistry, by Frederick Soddy, 355–404; Time and Space, by Alfred A. Robb, 405–429; Philosophy, by A. E. Taylor, 429–476; and The Religious Effect of the Idea of Evolution, by the Rev. James Maurice Wilson, 477–516.

In the words of the publisher, "This work is an attempt to state, in straightforward language, the views now held by representative British scientists," and as such it will be very welcome. The difficulty in compound undertakings of this nature is, however, to obtain a well balanced whole. This difficulty has not been overcome in this volume. In view

of its importance the section on Anthropology should have received much more space and been allotted to several men, one for Physical Anthropology, one for Archaeology and one for Cultural Anthropology; for to deal adequately with all these is to-day beyond the power of a single worker. It would be most useful if this and perhaps similar symposiums in other countries could be rewritten and republished periodically, say every ten years, and with only scientifically determined space limitation.

Bryan and Darrow at Dayton. Edited and Compiled by Allen (Leslie H.)—N. Y., 1925 (Arthur Lee and Co., $1.75).

A very serviceable volume, carefully edited, and supplemented by useful information giving the origin of the Dayton trial, and by an appendix giving brief notes on Bryan and Darrow, the essential part of the Genesis, and the involved paragraph from Hunter's "Civic Biology" by the teaching of which Scopes transgressed the law. Also there are several photos of the main personages involved.

In the compiler's words "To men and women of all religious beliefs and none, the Dayton trial was, and still is, of vital interest. Because of the implications of that trial, because the issues there drawn may be carried through the Supreme Court of Tennessee to the Supreme Court of the United States, this unbiased compilation of the essential facts about the Scopes case has been prepared as a contribution to contemporary history and as a ready reference record for a future in which those issues will loom ever larger until in men's minds they have been squared with the truth."

It is to be regretted that this serious record of one of the most deeply interesting trials in history has been given a dime-novel outer cover.

Why We Behave Like Human Beings. By Dorsey (George A.)—New York, 1925 (Harper and Bros.).

This is a breezy book by a live man in the best sense of the words. It is a production in every paragraph, every sentence, characteristic of and a part of the author. It sparkles with thought and abounds in vitality and is tinged constantly with humorous to biting satire and wit. It is a biological, physiological and psychological discussion of man. The object? Dr. Dorsey shows that "human beings are the most interesting objects of study in the world, and that their business of getting along with themselves and one another is the only really important problem in human affairs."

The scope: The Individual Life Cycle and the Human Race; The Evolution of the Earth, Life and Sex; The Processes of Living and the Germs of Disease; The Endocrine Glands and the Causes of Death; The Integrating Organ and Mechanism of Adjustment; Acquiring Human Behavior; From the Standpoint of the Newer Psychology.

The praise: The book is wholesome, stimulating, able, lively; it should and will be read widely.

The criticism: There are numerous minor errors of statement, perhaps hard to be avoided in a book of such a scope, but to be carefully eliminated in a future edition. Their correction will greatly strengthen the book.

Evolution and Christianity. By Goldsmith (William M.), with Chapters by Henry Fairfield Osborn, S. Parkes Cadman, Harry Emerson Fosdick and Lyman Abbott (Deceased); Introduction by Allyn K. Foster—8°, 1925, 2nd ed. Haldeman-Julius Co., Girard, Kan.

On the whole an able and high-level, though somewhat militant, discussion of the claims and objections of the anti-evolutionists. The author shows plainly that such antagonistic views now, as in the times of Darwin, are as a rule connected with a lack of proper comprehension of the subject. Moreover those who oppose this great natural truth do not always use fair means, particularly when addressing themselves to those who are not capable of critically weighing their words. The book is a scientific argument with and against those who have most sinned recently in the field it covers. Is it worth while? Perhaps so, for in a short time it has reached a second edition. Its scope will best be seen from the following headings of chapters: Claims of the Anti-Evolutionists; In Biology all Roads Lead to Evolution; Evolution Strengthens Christian Faith; Sarcasm, Ridicule and Misinterpretations Supplant Logical Reasoning; the Origin of Man; "Unexplained Origins" vs. the Evolution of Life; "Unanswerable" Challenge to Darwinism; "Atheism" in Our Universities; Similarity of Structure as an Evidence of Animal Relationships or of "Design;" Human Devolution or Human Evolution; Evolution Has not Collapsed; Early Writers see God in Nature; The Use and Misuse of the Bible; God and Evolution; Evolution and Religion; Mr. Bryan and Evolution.

Both Sides of Evolution. By Knight (Charles Spurgeon)—12mo, 2nd ed., 1925, 252 pp. (Arthur H. Field, $1.00).

This, if written by one and the same author, which seems very improbable, is a remarkable Jekyll-Jones-Hyde production, embodying pretty nearly the best, the good ordinary, and the worst that could be said to a popular audience about evolution.

The whole is presented as a "joint debate." There is a very fair general outline of the subject by "President Howard of the State University;" a somewhat belligerant and insufficient, nevertheless scientific, presentation of the subject from the standpoint of the evolutionist by "Professor Allen of the University;" and a poor "refutation" by Dr. Barkley, "the celebrated pastor of Trinity Church" of the same community.

The first section leaves little to be desired; the second, good as far as it goes, does not fully satisfy and fails perceptibly when it comes to the human evidence; while the last is an interesting human document showing in a typical way the superficiality and lack of true comprehension of those who have read but have not worked, could not assimilate properly

what was available to them, and are unable to rise to those broader and more inspiring horizons which are being opened by modern knowledge. This third part, with the help of many names and quotations, descends here and there not only to shallow sophistry and endeavor to obscure the issue, but dangerously near even to deception. The results naturally are rather pathetic, and harmful to that ill-defined something they endeavor to defend.

The text shows many misspellings of the more technical and even of some relatively simple terms, which are inexcusable in a second and as advertised "up to the minute" edition.

THE ASCENT OF MAN BY MEANS OF NATURAL SELECTION. By Machin (Alfred)—8°, N. Y., 1925, xx + 325 pp. (Longmans, Green and Co., $2.75).

"This book had its origin in the belief that if evolution was a fact it must have some definite meaning for the human race. . . If man is indeed a child of nature, the outcome and consummation of a vast process, then there exist the strongest grounds for believing that only by an understanding of this process will man get some clear understanding of himself and his situation." The essay "is based, in the main, on the works of the two giants of evolution theory—Darwin and Spencer."

The book deals with: The Case for Inquiry—Darwin; Natural Selection in Plants and Animals and in Man. Natural Selection according to Darwin and Wallace; the Law of Malthus applied to Man, to Plants and Animals; the Struggle for Existence; New and Old Conception of Natural Selection; The Ascent of Man by Means of Natural Selection—The Facts; The Instrument of Interpretation; Examination of the Facts.

The conclusions are that "the evolution of man can be explained as a natural process, and civilized man can be explained as the descendant of savage man by the operation of a natural selection of the fittest. . . . The struggle for existence did not derive from the competition between individuals for inadequate food supplies, but from the competition between species and species: the contest being for definite places in the economy of nature and dependent on the relative success in contending against enemies and the elements and in exploiting the food supplies available. The species and not the individual became the unit on which natural selection acted, the struggle being essentially between rival types, in which the fittest for a particular environment was 'selected' and the less fit eliminated." Progress in man "eventuated from the competition between combinations of men. With this revised conception of natural selection an attempt is made to interpret the outstanding features in the history of the human race. . . . The principle of natural selection, a simple principle postulating only unceasing competition, with continual elimination and selection, is seen to be the great law governing all the processes of plant life, animal life and human life. . . Evolution in the light of natural selection offers a clear and simple explanation of human nature and human societies. It affords illumination and gives guidance in all the problems of life."

THE DOGMA OF EVOLUTION. By More (Louis Trenchard).—8°, 1925 (Princeton Univ. Press, $3.50).

This volume "contains the substance of lectures delivered by the author at Princeton University in January 1925." The contents of the book, handicapped somewhat from the start by its title, are: Evolution as Science and Faith; The Greek Attitude towards Science; The Mediaeval Attitude towards Science; Palaeontology and Geology; the Positive Evidence for Evolution; Lamarck; Darwin; Life as Mechanism; Evolution and Society; Evolution and Religion.

The book is a high grade, though perhaps not wholly up to date, discussion of cold materialism rather than that of a wonder- and order- and beauty- full evolution. The author, while thoroughly versed in the older literature and views does not seem to sense the new and rejuvenating air in this realm of science. He still combats with the dead. He is erudite but not abreast with the emerging and ever brighter present. His attitude towards evolution is not made clear enough. It does not appear to be fundamentally adverse, yet he opposes the generalizations and applications of the knowledge as not sufficiently based and as not beneficial. His reason as a physicist for undertaking a discussion of biology and evolution is (p. 30), "that there is more urgent need for a critique of biology as it is the science which is furthest out of its field, and also its influence on life and thought is more direct and readily seen, than is that of the physcial sciences, and consequently, may be more pernicious." The purpose of the book (p. 34), "is not to discuss the validity of evolution as a scientific biological theory, but rather to trace the effects of its application to the broader fields of social life and religion." His dealing essentially with the "work and ideas of the founders of the evolution theory" is due to the fact that "modern biologists are still using the ideas and methods of their predecessors. If these ideas and methods are fundamentally wrong, then the monistic and naturalistic philosophy, which has followed from the doctrine of evolution and which is still dominant, will fall also."

The book is not easy to peruse and it lacks an index; but it is handsomely and faultlessly printed.

EVOLUTION AND GENETICS. By Morgan (Thomas Hunt)—8°, 1925, 2nd ed., 211 pp., numerous illustr's. (Princeton Univ. Press, $2.00).

This, a revised copy of the author's "A Critique of the Theory of Evolution," is an excellent treatise on the subject it deals with, and by one of America's foremost scholars.

The revision "is no less an attempt at a critique of the evolution theory than its predecessor, but, as the change in title suggests, greater attention is here paid to one of the most debated questions among evolutionists to-day, namely, the bearing of the recent discoveries in genetics and in mutation on the theory of evolution."

The book deals with: Different Kinds of Evolution; The Four Great Historical Speculations; The Evidence for Organic Evolution; The Materials of Evolution; Mendel's Two Laws of Heredity; The Chromo-

somes and Mendel's Two Laws; The Linkage Groups and the Chromosomes; Sex-Linked Inheritance; Crossing-Over; Natural Selection and Evolution; The Origin of Species by Natural Selection; the Non-Inheritance of Acquired Characters; and Human Inheritance.

Adequately to present the views of the author would call for much more space than is available. The book is full of noteworthy statements. One or two items may however be selected. As to the methods of evolution (pp. 38–39) "it is important to keep in mind the fact that animals and plants are extremely complex machines that are highly adapted to the conditions of life in which they live. Any change, and especially any great change in them, is far more likely to throw them out of balance with their environment than to bring them an advantage, but it is possible, nevertheless, that some of the changes, however slight, might be beneficial, especially those that add to or diminish slightly some important character or function already present. These changes might furnish materials for evolution.

"Darwin rested his case for evolution on the observed small differences that all animals and plants show. Now, while we realize to-day that many of these slight differences are not inherited, we also know that amongst them there are some that are inherited and that these, so far as we know, have arisen as mutations. At present there is no evidence that will stand the test of criticism in favor of any other origin than that all known variations owe their appearance to the same process of mutation that also produces the larger differences; and, I repeat, that there is much explicit evidence to show that very small differences, that add to or subtract from characters already present, do appear by mutation.

"Finally there is evidence that the differences shown by individuals in nature are inherited in the same way as are the observed mutant characters of domesticated forms."

In the final chapter much of interest is said in relation to genetics and heredity in man. The author's main view in these lines is as follows: "I am inclined to think that there are considerable individual differences in man that are probably strictly genetic, even though I insist that at present there is for this no real scientific evidence of the kind that we are familiar with in other animals and in plants." However, "Least of all should we feel any assurance in deciding genetic superiority or inferiority as applied to whole races, by which is meant not races in a biological sense but social or political groups bound together by physical conditions, by religious sentiments, or by political organizations. The latter have their roots in the past and are acquired by each new generation as a result of imitation and training. If it is unjust to 'condemn a whole *people*' meaning thereby a political group, how much more hazardous is it as some sensational writers have not hesitated to do, to pass judgment as to the relative genetic inferiority or superiority of different *races*. If within each human social group the geneticist finds it impossible to discover, with any reasonable certainty, the genetic basis of behavior, the problems must seem extraordinarily difficult when groups are contrasted with each other where the differences are obviously con-

nected not only with material advantages and disadvantages resulting from location, climate, soil and mineral wealth, but with traditions, customs, religions, taboos, conventions and prejudices."

The Earth Speaks to Bryan. By Osborn (Henry Fairfield)—N. Y., small 8°, 1925 (Chas. Scribner's Sons, $1.00).

Anything written on this subject by Professor Osborn is worthy of the closest attention of both the anti- and the evolutionists. Combining a vast store of sound biological knowledge with rare eloquence, the author presents herewith once more a contribution which is both authoritative and delightfully presented. If any wish remains it is that this book may have been more comprehensive; and that everything bordering on the controversial may have been omitted, including a reference to the still uncertain and here somewhat unnecessary Hesperopithecus.

The book deals with, I. The Tennessee Trial; II. Evolution and Religion; (The Author's first reply to Bryan); III. A New Inquisition; (The author refers to the coming Tennessee trial); IV. Evolution and Daily Living (The author shows that evolution demands the highest ideals of conduct); and V. Credo of a Naturalist (the author shows that a reverent study of Nature leads to religion).

The Origin of Man. By Read (Carveth)—1925, 8°, xii + 100 pp., (Cambridge University Press, England).

The book is written by an Emeritus Professor of Philosophy and Logic and is essentially discursive in the best sense of the word. More than this, however, it advances original—though independently shared by others— ideas about the causes and ways of man's origin. These in the words of the author, are briefly as follows: "The chief conditions to which mankind has been adapted and thereby differentiated in body and mind from the anthropoid stock are four—the hunting-life, geographical circumstances, social life and his own imaginations concerning Magic and Animism."

The book is a good example of scientific reasoning and will well repay earnest perusal. Its weakness, as could hardly be otherwise, lies in a lack of thorough first hand grasp of the material evidence of the earlier human forms.

Man's Life on Earth. By Schmucker (Samuel C.)—N. Y., 1925, 8°, xxix + 299 pp., numerous illustr's. (The Macmillan Co. $2.25.)

This book "claims no originality." It deals with: A Flight of the Imagination; A Gleam of Evidence; A Few Really Human Fragments; What are Eoliths; Dating the Work of Primitive Man; Low Brow Stone Age Man; High Brow Stone Age Man; The Ice Age; The Transition to Modern Times; The New Stone Age Begins; The Growth of Industry; The Rise of the Human Spirit; The Lake Dwellers; A Glance Around; Man To-Day; Man's Body a Witness; and The Religious Difficulty.

Even if not perfect here and there it is an exceptionally good primer which may be safely recommended to all who seek a sane and reliable introduction to the subject of Man's far past and of what is its meaning.

Concerning Evolution. By Thomson (J. Arthur)—New Haven, 1925 (Yale University Press, $2.50).

The book is an expansion of the three Dwight H. Terry lectures given by the author in 1924 at Yale University. It deals with "the Making of Worlds, the Evolution of Organisms, and the Emergence of Man." The author's object was to show that evolutionist description is not inconsistent with religious interpretation. Indeed the evolutionist view of Nature and of Man makes for enrichment and encouragement. "The lectures are not systematic expositions of evolution in the domain of things, the realm of organisms and the kingdom of man; they are intended rather to show how evolutionary science may illumine the religious outlook."

The volume is illustrated with 25 figures which, however, are not very successful. And it ends very commendably with a Summary of which the following is a gist: "The incorporation of large new facts and new ideas into the framework of our thinking often means disturbance. . . . What Darwin proved was Man's solidarity with the rest of creation. He demonstrated Man's affiliation to an extinct stock common to him and to the anthropoid apes. The evidence of this may be found in the close anatomical similitude, in Man's numerous vestigial structures, in Man's individual development, for a time so like those of the higher Primates, in the similarity of humanoid and anthropoid functions and in the existence of 'tentative men' who came before Homo. We may recognize all this solidarity without abating in the least our appreciation of Man's apartness—in reason, in language, in vivid self-consciousness, and in moral agency. . . Darwin also sought to show how demonstrable factors of variation, heredity and selection may have operated in Man's emergence. Our knowledge of these factors remains confessedly slight and vague, but the inquiry is still young, and it is bad thinking to use our confession of ignorance of the *factors* as if it implied any dubiety as to the *fact* of Man's natural evolution—a fact in the sense that all the scientific evidence points to that mode of emergence. . . There can be no radical antithesis between the scientific description of Man as the outcome of a process of natural evolution and the religious interpretation of Man as the child of God.

"It is probable that Man arose as a mutation. In his ancestry the period of arboreal apprenticeship probably counted for much—e. g., in the emancipation of the hand, the recession of the snout region, the enlargement of the brain-case, the shunting forward of the eyes, and changes in the brain. But the critical time was probably when climatic changes brought about a shrinking of the forests and the humanoids came to earth. That involved a struggle for existence in which the premium was on wits rather than on strength. . . . "

As to further evolution, "Two lines of possible evolution seem to be

particularly promising, an increase in the complexity of cerebral inter-relations and a change of the rhythm of life so that the youthful period is extended and the senescent period abbreviated. . . .

"The evolutionist picture gives the world a new unity; the groaning and travailing of creation finds a new meaning when Man is discerned as its outcome; the elaborateness of the foundations is more intelligible when recognized as in part a foundation for the lofty superstructure; perplexing anachronisms in our nature receive historical elucidation. The evolutionist view is encouraging and strengthening, for evolution is on the whole integrative and makes for the emergence of mind and personality; its momentum is with us at our best; it is an ascent not a descent that lies behind us."

Evolution for John Doe. By Ward (Henshaw)—8°, Indianapolis, 1925. (The Bobbs-Merrill Co.).

The volume as characterized in the Foreword is a treatise which gives "in forceful, popular language a vivid general view of what is meant by organic evolution. It gives just such a survey as a person unacquainted with biology needs for an introduction to some of the large problems of life."

The scope of the book is: A Description of Evolution: What John Doe thinks about Evolution; the Myriad Forms of Life; the Tangled Web of Life; the Varied Modes of Life; the Jungle of Adaptations; the Struggle for Existence; Variation; Heredity; Natural Selection; The Evidences of Evolution: What "Evidences" are; the Evidence from the Rivalry of Scientists; from the Rocks; from Geographical Distribution; from Classification; from Artificial Selection; from the Structures of Animals; from Embryos; from Blood; The History of Evolution: Lamarck; Darwin; Weismann; Mendelism; DeVries' Mutations; How Evolution stands to-day; The Fosdick Idea; with Bibliography and Index.

The book is of a high standard and freely commendable. It may be read with considerable profit even by the scientists. And there are excellent illustrations.

The World's Most Famous Court Trial: Tennessee Evolution Case—National Book Co., Cincinnati, 1925.

The National Book Company deserves credit for preserving in this convenient form the full records of the Dayton trial, or rather mistrial. It is a human and legal document of much interest, even though the scientific evidence could only be presented in an imperfect form. The book should be preserved in the library of every man of science as a striking memento of the difficulties of human progress against ignorance and aroused human conservatism.

The text, regrettably, is marred by typographical or spelling errors which ought to be carefully removed from a new edition.

EARLY MAN

THE ICE AGE. By Peake (Harold J. E.) and H. J. Fleure—*Man*, 1926, XXVI, No. 1–16, 4–8.

"The suggestion in this paper is that the Pleistocene period witnessed oscillations of the relations of land and sea in North-west Europe. That these oscillations were the echoes, as it were, of the great Alpine movements of the Oligocene and Miocene, and that along with these oscillations there may well have been eustatic movements, locking up water in periods of glacial growth and increasing the volume of the seas in periods of glacial decline. The estimates are necessarily provisional. The effects of elevation and depression upon climate in North-west Europe would be open to much misinterpretation were we to leave out of consideration the Wyville-Thomson ridge." The authors advance the "possibility of the view that on the one hand elevation and glaciation, and on the other depression and geniality were synchronous."

NEUERE FUNDE UND UNTERSUCHUNGEN FOSSILER MENSCHENAFFEN UND MENSCHEN. By Mollison (Theodor)—*Ergeb. Anat. & Entwicklgs-gesch.*, 1924, XXV, 696–771.

A very helpful survey of the more recent as well as some of the older skeletal finds of fossil apes and early man, with bibliography and illustrations, and numerous, if brief, indications of personal inclination. One cannot but express a strong wish that an author of such note may give us some day the results of original research in this field, particularly on the pre-human forms.

O SIGNIFICADO GENEALÓGICO DO "AUSTRALOPITHECUS" E DO CRANIO TABGHA E O ARCO ANTROPOFILÉTICO INDICO. By Mendes Corrêa (A.A.)—*Trabalh. da Soc. Portuguesa de Antrop. e Etnol.*, 1925, II, Fasc. III, 249–286.

A sensible article in which the author recognises the interest of the Taungs find, but points out that the specimen affords no justification for placing the form in the direct phylum of man or regarding it as humanoid.

He also discusses the skull of Galilee and man's genesis.

DER TAUNGS-FUND, EIN JUGENDLICHER MENSCHENAFFE. By Wegner (Richard N.)—*Die Umschau*, 1925, Jhrg. XXIX, H. 22, 429–433.

In this critical article, beautifully illustrated, the author shows that there is no valid reason for regarding the Taungs ape as a form in the human phylum. He inclines to view it as a fossil anthropoid ape related to the gorilla.

THE LONDON SKULL. By Smith (G. Elliot)—*Brit. Med. J.*, Nov. 7, 1925, repr. 6 pp.; also, under same title, in *Nature*, Nov. 7, 1925, repr. 8 pp.

In these two papers the well known author gives us brief information of the earliest human specimen yet revealed in the City of London.

It is the posterior portion (the occipital with parts of the parietal) of a female adult skull, found during excavations of the site on which stood originally the historic East India House. The specimen lay in the "blue clay" of the "third terrace" of the Thames, 42 feet below the surface. Though the fossil is believed not to be earlier than of the Aurignacian period, it nevertheless shows affinities with the Neanderthal type. In the author's opinion the "lady was an exceptionally primitive member of the species 'sapiens,' rather than a belated Neanderthaloid." However, "without the front or the face it is not possible definitely to exclude the possibility that this skull may belong to the Neanderthal species," though the probabilities are against such a conclusion. But "this uncertainty does not diminish the interest of the London skull; for the enigma of its affinities emphasizes how closely a primitive type of *Homo sapiens* may approach the Neanderthal species . . . The likeness of the cerebral part of the endocranial cast in the London and Neanderthal women involves not only the contour of the outline but also the modelling of the surface." Certain appearances seem to indicate that the subject was left-handed.

Das jungpaläolithische Alter des Ochoskiefers. By Bayer (J.)—*Die Eiszeit*, II, H. 1, Leipzig, 1925, 35–40.

The Ochoz lower jaw, discovered in 1905 in a cave in the Devonian limestone northeast of Brno, Moravia, and regarded formerly as older palaeolithic, is believed by the author, on the basis of a new critical study of the subject, to belong really to the Solutrean or Magdalenian period. Both the paper and the illustrations are of value.

Neue Beiträge zum Kiefergelenk des diluvialen Menschen von Krapina. By Gorjanovic-Kramberger (D.)—*Izv. Mat.-Prirod. Razr.* (Bull. Mathemat.-Natural Research), Zagreb, 1924, 118–145.

As a result of further painstaking studies on the parts forming the articulations of the lower jaw in the Krapina Man, the author concludes that these parts show much variation, together with advanced specialization. The glenoid fossa is shallower than that of man of to-day. A study with interesting conclusions is also made of the Heidelberg jaw.

Was the Chancelade Man Akin to the Eskimo? By Keith (Sir Arthur)—*Man*, Dec. 1925, No. 116, 186–189.

A notable contribution to the controversy about the Eskimo relations of the Chancelade skull. The author shows, conclusively it would seem, that characteristics shown by the skull occurred and may still be found among the Cro-Magnons and whites of Europe, and that the resemblances of the cranium to that of the Eskimo are but partial and associated with decisive differences.

The reviewer is ready to add his testimony to that of Sir Arthur. He personally examined the Chancelade skull and skeleton in 1923 and has also ample experience with the Eskimo (see his "Catalogue of Human

Crania in the U. S. National Museum Collections," 1924, where he gives measurements on 412 Eskimo skulls, etc.). He can state that the Chancelade skeleton, while presenting certain Eskimoid features in the skull, is not the skeleton of an Eskimo nor even, evidently, of any group physically allied to the Eskimo. It is perhaps not generally appreciated that at the time the Chancelade man lived there was in all probability as yet no Eskimo of the present type in existence. The affinities of the skeleton, considering all its parts and not merely the skull, which in some respect, looks more or less "Eskimoid," are with the Europeans of his time. A. H.

The Renascence of the Cro-Magnons.—"The Cro-Magnons, a race apparently of high development and intelligence, appeared in Europe some 25,000 B. C. and vanished about 10,000 B. C. They have reappeared in recent years and are growing more numerous and important with each new publication, until they may soon take the place of the Nordic as the center of controversy—which has perhaps been forestalled, however, by the assertion of Oscar Montelius that the Nordic is simply the Cro-Magnon, isolated and purified by millenia of life in Scandinavia.

"Dr. Paudler, the latest contributor to the subject (Die hellfarbigen Rassen und ihre Sprachstaemme, Kulturen und Urheimaten. By Fritz Paudler, Heidelberg, 1924, Carl Winter) will go farther. He describes two modern Cro-Magnon races, one in Northwestern Europe, to which he gives the name of Dalic race, and one in Southern Europe and Northern Africa (Berbers, etc.). The northern branch is taller and lighter, the southern shorter and darker, but still to be classed as a blond, Europe having now, under this scheme, three blond races, for the Nordic is still admitted to this noble company."

Paul Popenoe, *J. Hered.*, XVI, No. 5, 1925.

Eine Ërgänzung der Weichteile auf Schädel und Oberkörperskelett eines Neanderthalers. By Eickstedt (E. von)—*Z. Anat. v. Entwicklungsgesch.*, LXXVII, H. ¾, 1925, 363–380.

On the basis of anatomical data and of casts, the author has attempted a new reconstruction of the Neanderthal man. The result resembles considerably those of McGregor. The lack of beard mars the effect, however; and if the photograph is correct, there would also seem to be desirable more facial definition. Copies of the bust can be ordered from the author (Wien I, Burgring 7, Austria).

On the Recognition of Several Species of Post-Mousterian Man: and the Need for Superseding the Frankfort Base-Line. By Pycraft (W. P.)—*Man*, 1925, No. 105, 117.

At the Southampton (1925) meeting of the B. A. A. S. the author "brought forward a plea for the recognition of specific types in the Genus *Homo*, and a drastic revision of our methods of craniology."

In this complete paper (for a brief preliminary summary see *Man*, 1925, 99) Dr. Pycraft adds two additional "species" of man, and discusses a modification of craniometric procedures, advocating especially a new plane of orientation of the skull. His radical subdivisions he explains thus: "In preparing my Report on the Boskop skull I became more and more convinced of the absolute necessity of breaking away from the traditional conception of the Genus *Homo* and definitely recognising the existence of an indefinite number of species and sub-species... Our conception as anthropologists, of 'Races' and 'Species' and 'Somatological Units' is in a state of 'mush.' This is "Because all have been built up of materials which cannot possibly hang together. Abstract conceptions, ethnical and superficial somatological characters, have been hopelessly mixed up."

Dr. Pycraft's method of classification of man is "based primarily on the use of superimposed contours." Next he uses a new base-line, the auriculo-nasion line passing from the nasion through the middle of the auricular meatus. This line practically separates the cranium from the face. The Frankfurt-Agreement line is misleading, "it has not a single redeeming feature, and should henceforth be discarded." Further advantage of the new line is that the position of the meatus is less variable than that of the basion; that it may be used in the many older skulls in which the whole face is wanting; that there is a definite relation between the facial angle obtained with the help of this line and the alveolar index; and that it "affords what no other Base-line will afford, a reliable and uniform standard of comparison between the skulls of different types."

Summarizing his views, Dr. Pycraft believes that: "We must build upon the foundations furnished, in the first place by skulls like those of Eoanthropus, Mousterian man, the Aurignacian and Magdalenian types, the Boskop, Negro, Pre-Dravidian, Tasmanian and Polynesian types, and so on. These and others yet to be defined are to form our standards of comparison. One or other of these will have to be taken into consideration in our endeavors to distinguish specific forms of the Genus *Homo*. They will afford us positive standards of comparison enabling us to detect the character and degree of "mongrelisation" or "miscegenation" which has taken place in any given skull. The superimposed contours of the *Norma lateralis* will prove the best guide for the initial stages of the investigation. The clue thus afforded must be followed up by careful comparisons between the various *normae* as well as in regard to other structural characters, to be found not only in the cranium but also in other parts of the skeleton. Nor may we neglect evidence afforded by dissection which must be used in addition to the more superficial characters hitherto alone taken into serious consideration."

To the reviewer it seems that the new classification advocated by the ingenious author is unnecessarily radical; that the new base-line has a distinct merit and may be found of much help to anthropometry; but that classification of a high and composite variable such as the skull by simple super-imposition of contours, as by any other attractively simple method, might not seldom, unless used with the greatest expert care, prove misleading.

RACES: TRIBES

(Classification of Human Races). In Czech, with good abstract in French. By Matiegka (J.)—*Anthropologie* (Prague), 1925, III, No. 3, 220–264.

A comprehensive review of the many efforts at human classification, which will be very useful to students of anthropology. The author abstains from adding his own views, but groups the classifications so far advanced into Geographical, Polygenetic and Phylogenetic; and concludes with Topinard that "Anthropology is still in the analytical phase; it still lacks definition of true types, and the true relations of the types of man are still wholly to be established."

Methods of Racial Analysis. Significance of the Term "Race." By Hooton (E. A.)—*Science*, Jan. 22, 1926, 75–81.

In his vice-presidential address to Section H, American Association for the Advancement of Science, December 1925, Dr. Hooton discusses ably a subject of great importance as well as difficulty to anthropology, namely that of proper racial classification. For him the race is "a great division of mankind, the members of which, though individually varying are characterized as a group by a certain combination of morphological and metrical features, principally nonadaptive, which have been derived from their common descent." He distinguishes primary, or unmixed, and secondary or composite races, the latter being much more common; and deals with the criteria of race with their application. His own method, more particularly in craniology, is a thorough morphologic as well as metrical analysis of the material, with subsequent careful comparisons. There is no short-cut method.

The Hybrid as a Sociological Type. By Reuter (E. B.)—*Publ. Am. Sociol. Soc.*, 1925, XIX, 59–68.

"There are no ethnically unmixed groups in the modern world, and all persons are, in consequence, hybrid. These hybrids being for the most part the offspring of parents of nearly related racial types, are not markedly different in appearance from individuals of the parent races and are not sociologically significant. But in some cases the hybrids are the offspring of individuals of physically divergent racial groups. In such cases the hybrids are in appearance unlike the members of either parent race and are unable to pass as members of either the one race or the other. The physical appearance thus determines a social type by determining the social status of the hybrids in the biracial situation. In all cases these hybrid groups resulting from the amalgamation of physically divergent races are superior in social position and in intellectual achievement to one racial element of their ancestry. This superiority cannot be explained in biological and ancestral terms, but is readily amenable to explanation in terms of mobility and social contact."

A Classification of Human Races Based on Geographic Distribution of The Blood Groups. By Ottenberg (Reuben)—*J. Am. Med. Ass.*, 1925, LXXXIV, 1393–'95.

The writer has taken the available data on the agglutinogen contents of human blood and attempts their grouping. He obtains six main groups which partly correspond, partly do not correspond to racial groupings based on other characteristics. However, the author's intent was not to offer a new race classification, but "merely to arrange the available blood group data in as natural a manner as possible, in the hope that their significance will then be elucidated and reconciled without present conceptions of racial relationships by those properly qualified to do so. That the data have some, though possibly a limited bearing on racial origins is hard to doubt."

Recherches Sérologiques sur les Races en Roumanie. By Popoviciu (Georges)—*Rev. anthropol.*, 1925, XXXV, 152–164.

As a result of extensive studies the author reaches the conclusion that in serological research on any given human group local variation is such as to make it necessary to obtain data on all the regional subdivisions of the group. A large number of tests (5,458) on the peoples of Rumania give interesting indications of apparently anthropological importance.

The Old Americans. By Hrdlička (Aleš)—8°, 1925, pp. xiii, 438, 48 portraits, numerous charts. (Williams & Wilkins, $10.)

The term "Old American" is applied by the author to those American whites who have been longest in this country. More specifically, it includes those of whom both parents and all four grandparents, at least, were native-born. The third native generation of adults means roughly a family American residence of 80–150 years, but the mean term of residence of those actually examined in these studies probably surpassed 150 years for there were many who exceeded the minimum requirement of three generations.

The objects of the studies the results of which are reported in this volume, were, (1) The establishment of reliable anthropometric norms on the normal adults of this country; and (2) The elucidation of the questions: Has the older American complex been subject long enough to new environment and sociological and other influences to have developed into a new sub-type of the white race; Are the physical changes it may present in the direction of improvement, or is there also some degeneration; Has the type, if it is one, reached and passed its zenith or is it still on the upgrade; How will the type be affected by the admixture with more recent immigration, and What are the indications as to its future developments.

The studies extended from 1910 to 1924, partly in the Laboratory of Physical Anthropology of the U. S. National Museum, partly outside (Massachusetts, Connecticut, Tennessee, Virginina). The total number of Old Americans measured, with the assistance of Prof. R. B. Bean,

reached to more than 900; while about a thousand in addition were examined especially for pigmentation etc. Those examined may be regarded as fairly representative of the stock. Subadults and the senile, the abnormal or those in poor health were excluded. Clerks, business and professional men, members of Congress, men of leisure, artisans, farmers, comprise the occupational range of the men examined. The women included no laborers or servants—there are practically none among Old Americans—but women in professional and business life, clerks, housewives, women of leisure. In addition there are incorporated with this volume all earlier anthropometric data on American adults and the records on twelve groups of recent immigrants to the United States.

The contents of the book are as follows:

CHAPTER I

Introduction

CHAPTER II

Historical Sketch of the Old American Stock

CHAPTER III

Pigmentation:

Color of Skin; Color of Hair; Geographical Differences; Red Hair; Anomalies of Hair Pigmentation; Nature of Hair; Color of Eyes; Geographical Differences; Correlation of Eye and Hair Color; Anomalies of Eye Pigmentation; Blonds and Brunets; Grey Hair, Loss of Hair; Conclusions.

CHAPTER IV

Measurements and Morphological Observations:

Stature; Weight; Height Sitting; Arm; Head; Head Length; Head Breadth; Head Height; The Three Head Diameters and Head Form; Head Shape; Mean Height Index; Size of Head; Face; Facial Constiuents; Forehead; Eyes; Check Bones; Nose; Mouth; Chin; General Notes on Face; Adiposity; Wrinkling; Sub-Nasal Portion of the Face; Lower Facial Breadth; Ears; Chest; Hand; Foot; Leg.

CHAPTER V

Physiological Observations:

Pulse; Respiration; Temperature; Muscular Strength.

CHAPTER VI

Abstracts:

I. North and South, II. Variability, III. Influence of Age, IV. Influence of Stature, V. Influence of Head Form, VI. Comparative.

CHAPTER VII

The Future American Type

Index

For the details, many of which are of considerable interest, the reader must be referred to the original.

Les Colonies Néerlandaises aux États-Unis. By Hinte (M. J. van)—*Rev. anthropol.*, 1925, XXXV, 190–196.

A discussion of Dutch emigration to the United States and of several of the earlier Dutch settlements in Michigan, Illinois, Iowa, Wisconsin, New Jersey, etc. The total number of Dutch immigrants to the States between 1820 and 1920 was (U. S. Census), 220,000. The Dutch immigrant assimilates rapidly, but wherever settled in numbers has left plain traces of his presence.

The Dyfi Basin: A Study in Physical Anthropology and Dialect Distribution. By Peate (Iowerth Cyfeiliog)—*J. Roy. Anthrop. Inst.*, 1925, LV, Jan.–June, 58–72.

"The Dyfi Valley is a forested valley basin between the hills of Plynlymon on the south and those of Merioneth on the north (in Wales) and these bare mountains have exported their men into the intermediate valley, and in that valley a fusion has been to some degree effected, for the dialect is to a large degree uniform throughout and at the same time there is a certain uniformity of physical type (the largest percentage of the people being neither markedly brachy- nor dolichocephalic, neither very tall nor very short). But the fusion has not been complete and so a line easily traceable along the length of the valley from east to west marks the boundary between definite differences in physical anthropology and phonological detail of dialects. The Plynlymon home of narrow-headedness and the Merioneth belt of broad-headedness have supplied men to the south and north of the basin, and so both distributions of speech and physical types are related to the same sort of causes, and provide a definite cause of correlation."

Körpermasse und Körper-Proportionen der Islander. By Hannesson (Gudmundur)—8°, Reykjavik, 1925, 254 pp.

A comprehensive and able report on 884 men 20 to 40 years of age attending the higher schools of the island. The memoir presents besides generalities sections on Stature and Weight, Height of Head and Length of Neck, the Trunk, the Extremities, the Head, Pigmentation, and an ample English Summary (pp. 235–252), with Bibliography. The main results are: Average statures 173.55; C. I., 78.13; height of head, medium and above; face mainly leptoprosopic, nose leptorhinic. Valuable comparative data on the Norwegians are added. Pigmentation of eyes is mostly light, but hair is not infrequently dark.

Anthropologische Studien an Norwegischen Frauen. By Schreiner (Alette)—*Videnskapsselskapets Skrifter*, I. Mat.-Naturv. Klasse, 1924, No. 9, Kristiania, 1924 (Jacob Dybwad, Kr. 5.00).

Report of a detailed painstaking anthropometric study of 193 Norwegian women from various parts of the country. The averages obtained were in the main as follows: *Stature*—162.36 cm. (stand. dev. 5.44 cm., coeff. of var. 3.35); height sitting—53.3 p. c.; arm-spread—

163.76 cm. *Head*—length, 18.5; breadth, 14.9 cm.; C. I. *80.9* (in 76 percent = 77.-—83.9; 4 p. c. below 76, 50.6 p. c. 76—80.9, 40 p. c. 81.-—85.9, 5.4 p. c., 86 and above); *Face*—morphologic height, 11.06; breadth, 13.19; index *83.7*; *Nose*—height—5.12; breadth, 3.20; index, *62.6*. As to pigmentation the eyes were, approximately, brown in 10.4, intermediate 26.2, light 63.3 per cent; hair, red, 0.6, dark brown, 3.-, brown, 39.5, dark-blond, 44.9, intermediate blond, 5.7, blond, 63 p. c. (or dark 42.5, light 56.9 p. c.). The stature is higher than expected from the height of the men and may in some way have been biased.

The good work of Mme. Schreiner deserves to be extended.

Die anthropologische Untersuchung des Finnischen Volkes. By Kajava (Yrjö)—*Anthrop. Anz.*, Jhgr. II, H. 4, Stuttgart 1925, 228–253.

An important article giving, besides valuable new data, a summary of all the more significant previous contributions to the anthropology of the Finns. From the author's own work it appears that the stature, which now in males averages, according to districts, from approximately 169.5 to 172.5 cm., has generally augmented within the last 120–150 years from 1.4 to 3.1 cm. The mean cephalic index ranges from 79.2, 79.4, 80, and 80.9 in the western districts, and 80.5, 80.9 with 81.3 in the central parts, to 81.2, 82.15 and 82.6 in the northernmost and the eastern parts of the country. As the Swedish influence is most prevalent in the western districts and diminishes eastward, it would appear from these data that the true Finns were of medium stature and brachycephalic.

Slavonic Nations of Yesterday and Today. By Stanoyevich (Milivoy S.)—New York, 1925, xlvi + 415 pp. (The Handbook Series, H. W. Wilson Co., $2.40.)

"The design of this volume is to afford the reader a general view of the Slavonic nations from the earlier to the present time . . . There are many books dealing with the subject, but most of them are in the original and inaccessible to English-speaking people. The editor has here brought together readable examples of the most important writings, and practical illustrations of the rise of learning, imagination and crative power which finally brought about the liberation of this race. There are chapters on Russia, Poland, Czechoslovakia, Yugoslavia and Bulgaria; also a selected bibliography." The selected contributions represent no less than sixty authors. Of indirect interest to physical anthropology.

Die Tschechoslowakei. By Hassinger (Hugo)—Leipzig, 1925, pp. ix + 618 with map.

A well written and well printed book full of geographical, historical, ethnic, statistical, economic and political information about the new and progressive Republic in central Europe and its people. It is the most comprehensive and also one of the fairest presentations of the

facts by a German writer. There is an exhaustive List of Contents (sections: General; Geography; Subdivisions; People and Culture; Statistics, Minorities; Roots of People and State; the State and its Political Aspect; the Past and the Future); and a good Bibliography. Of indirect interest to physical anthropology.

(Analysis of Anthropological Types.) In Polish. By Stolyhwo (K.)—*Swiatowit*, 1924, XII, No. 4, 96 pp. (Résumé in French.)

On the basis of an extensive study of the anthropological types in certain parts of Poland (Distr. Ostrow), the author comes to the conclusion that the most prevalent and characteristic type of the population is that of light-haired, blue-eyed, medium-stature brachycephals; and he regards this strain as one of the more fundamental types of Europe (the others being the *nordic*, *alpine* and *mediterranean*). He believes this type had once, and still has, a wide distribution in central and northern Europe and is in an important way connected with the Slavs.

Beiträge zur Anthropologie der Ukrainischen Wolhynier. By Pöch (Hella)—*Mitt. Anthrop. Ges. Wien*, 1926, LV and LVI.

Mme Pöch gives herewith valuable detailed observations and measurements on a large series of Ukrainians from Volhynia, the southwesternmost province of Russia, who were confined in one of the Austrian detention camps during the World War. The interesting results (which regrettably, as in most German publications, are not summarized), are supplemented by 54 good portraits of the people, more particularly the women.

The Ancient Inhabitants of the Canary Islands. By Hooton (Earnest)—1925, 4°, pp. xxv, 401, 39 pl. 37 figs in text, (Cambridge, Harvard African Studies, Vol. VII).

Dr. Hooton's book is a highly creditable piece of work as well as a fine piece of printing. It is the result of the author's expedition to Tenerife in 1915 and the study of the rich Guanche collections (454 crania, besides cultural material) in the Museum of Sta Cruz.

The memoir deals with both the customs and material culture of the Canaries, and with the physical anthropology of their ancient people. The whole scientific literature bearing on the same is utilized and there are many data of comparison. The scope of the work will best be seen from the headings of the chapters, which are: General Ethnography of the Canary Islands in Antiquity; Social Anthropology and Archaeology of Tenerife; Commentary on the Customs and Material Culture; Pigmentation, Stature and Bodily Proportions of the Ancient Inhabitants of the Canary Islands; Cranial Measurements and Indices; Summary and Discussion of Observations; Comparison of Tenerife Crania with those of other Peoples, (a) Recent European and North African Crania, (b) The Relation of the Guanches of the Canary Islands to the so-

called "Race of Cro-Magnon;" Association of Morphological and Metrical Features; Determination of Morphological Type; Correlations and Inheritance; Conclusions; with two Appendices and Bibliography.

Dr. Hooton's conclusions are of much interest. He believes to see evidence that the Canaries were peopled successively by four distinct strains of man, coming from Africa and possibly the Mediterranean. The first settlement took place some time in the Neolithic period, the last in the Bronze Age (in the Mediterranean). There were subsequent accretions (Arab, Berber etc.), but these were of less importance.

As a result of these studies, Dr. Hooton makes a number of noteworthy suggestions concerning the Cro-Magnon type, and the origin and development of the European races, which should be read in full. How far they are justified can probably only be shown by further studies; there is still much, very much to be done in these lines before we shall see clear. He ends however with an expression of his views on "Race and environment" which deserves to be quoted in full (p. 308): "It is no longer possible to argue that the many clearly distinct modern races of man are the result of some miraculous process of environmental differentiation carried on throughout ages in theoretical areas of geographical isolation. From early prehistoric times physically diverse types of men have intermingled their blood and their cultures. Favorable combinations arising from such hybridism have resulted in the establishment of new races and new cultures, especially where the fusion has been complete and where environment has operated selectively. There is probably not one fundamental human character which owes its origin solely to environment. Environment selects and sorts mutations and the combinations of hereditary characters; it may determine survival or extinction. Environment moulds and modifies, but it never creates. Logic inevitably leads from this point to the conclusion that the modern races of man have arisen from the selective action of environment upon the various mixtures of several fundamental human stocks which had evolved from distinct though related anthropoid ancestors."

There are two valuable appendices, one giving the notes on the author's exploration in the islands, the other devoted to the detailed measurements and notes on the studied crania. And there is a rich Bibliography.

The Ancient Libyans According to Egyptian Sources. In *Z. d. Morgenl. Ges.* LXXVIII, 1924, pp. 36–63, G. Möller gathers up all the references in Egyptian inscriptions to the Libyans, and illuminates these from classical and ethnological sources. The comprehensive name for Libyans in Egyptian was *Tehenu*. They first appear in pre-dynastic inscriptions. They are depicted with dark skins and dark hair. Men and women alike wear a curl on the forehead, a necklace, two broad leather bands crossing the breast, and a wide girdle to which a phallus pocket is attached. Even the women wear this pocket over a small apron, probably as a symbol of royal authority, like the male attire

worn by Queen Hatshepsut. This costume resembles the earliest Egyptian, and linguistically and in other ways there was a close conection between the Egyptians and the Libyans. About 2400 B. C. the new clan of the *Tuimah* appears among the Libyans. These are represented as blond and blue eyed. They wear caps of ostrich skin, and tunics that reach to the knee. These are to be regarded as immigrants from Europe who largely displaced the primitive Hamitic Libyan population. Both ethnological types continue to appear in the later inscriptions, and continue down to the present time.

Edward H. Heffner, *Am. J. Archaeology*, 1925, XXIX.

EGYPTIAN MUMMIES. By Smith (G. Elliot) and Warren R. Dawson—N. Y., 1924, 4°, 190 pp., 71 pl. (The Dial Press, Inc.).

A luxuriously printed and illustrated volume of interest to physical anthropology through the many good portraits of mummies and through the comments on Egyptian pathology. The Contents are: Introduction; The Death and Burial of an Egyptian; Egyptian Texts relating to Embalming; Embalming according to Herodotus and later Authors; Mummification in the Old and Middle Empires; Mummification in the xviiith to xxth Dynasties; Mummification in the xxist Dynasty; Mummification from the xxiind Dynasty to the Decline; The Accessories of the Mummy; Mummification in Relation to Medicine and Pathology; Conclusion and Appendix. The centuries-old practice and progressive frequency of mummification must have had an effect on positive knowledge concerning the human frame and organs. It had also much influence on medicine. The diseases, a material record of which was preserved by the mummies, include: Calculi (very rare); arterial disease; bilharzia; tuberculosis (rare); no rickets or syphilis; osteosarcoma (rare); true cancer (only late, in Byzantine times); cleft palate and club foot (but one case of each); gout (one typical case); dental caries and abscesses (very rare in pre-and protodynastic times, more frequent later); rheumatoid [senile] arthritis (generally present in the old, all periods); appendicitis (one case), pleurisy (one case); pelvic abscess (one case); leprosy (one case); mastoiditic ulceration (rather frequent); smallpox (possibly one case); fractures (common).

WHAT HAS BECOME OF THE PHILISTINES? In *Pal. Ex. Fund*, LVII, 1925, pp. 37–54, 68–79 (4 figs.) R. N. Salaman discusses the three distinct racial types that are found among the modern Jews. The first of these is the Semitic type with a long face and long nose that is not hooked, like the pure Bedawy Arab type and the early Egyptian representations of Semites. It goes back to the pure-blooded primitive Hebrew invaders of Canaan and to Semitic Amorite admixtures. It is exhibited by only fifteen per cent of modern Jews. Second, the Hittite, or Armenoid type. This has a round face and large hooked nose, exactly like the Hittite sculptures and the Egyptian representations of Hittites. It goes back to the aboriginal pre-Semitic population of Canaan and to the Hittite invaders. It is found in fifty per cent of

modern Jews, and has come to be regarded as the characteristically Jewish type of face. Third, the Pseudo-Gentile type. Among Jews of the purest Jewish descent about twenty per cent show a fair-skinned, long-headed type, with small delicate features and Greek noses. These could easily pass as Gentiles. This type is not due to Teutonic admixture in Europe, since in mixed marriages the Teutonic type is dominant, while the Pseudo-Gentile type is recessive. It is due to the absorption of the Philistines by Israel. The Philistines came from Crete, and their racial type as depicted in the Cretan and the Egyptian monuments was identical with the modern Pseudo-Gentile Jewish type.

Edward H. Heffner, *Am. J. Archaeol.*, 1925, XXIX.

THE PEOPLES OF ASIA. By L. H. Dudley Buxton, M. A., F. S. A., Lecturer Physical Anthropology, University of Oxford. (The History of Civilization, by C. K. Ogden, M. A.). New York, 1925, pp. xiii, 271. (Alfred A. Knopf, $5.)

As a result of a round-the-world journey, combined with his other studies, Dr. Buxton has given us a very readable and good book on a subject of much importance. It is not too much to say that if we had a thorough knowledge of the racial history of Asia we should be very near a final understanding of the history of mankind as a whole. For the great central continent, intimately connected on one side with Europe and Africa, opens on the other side towards the rest of the world and has for many thousands of years in fact during the whole postglacial time, if not before, been receiving human groups, augmenting and mixing them, and eventually sending their offshoots in all directions. Many writers as well known would, without bothering about proofs, make of Asia and particularly of its inhospitable central parts the very cradle of man—a loose notion to which our author is too sensible to subscribe before conclusive evidence be presented.

The volume deals with: The Races of Asia; the Origin of the Asiatic Races; Western Asia; India; China; The Fringing Lands of China; Arctic Asia; Japan; South-Eastern Asia and Indonesia; with Summary, Bibliography, Index of Tribal Names and General Index. The ideas expressed are in general pleasingly sound, even if not final or wholly devoid of the influence of past views and tendencies. There is much that will be changed in future editions if the author as is to be hoped will persist in personal field observations and as he overcomes the incubus of the past. The illustrations will be replaced, the bibliography unified and amended, and as experience accumulates the reliance upon indivindices, symbols or mathematical processes will probably grow less. But already as it is the volume may well be recommended to students of the problems it deals with.

The main conclusions of Dr. Buxton are as follows: "Biologically the majority of the races of Asia from the extreme west to the east are closely connected with those of Europe. The distinctions between them are probably not greater than might be said to warrant the term localities, although in some cases the differentiation seems to be suffi-

cient to make the use of the word 'sub-race' admissible. In Eastern Asia, however, seems to be very widely spread a group of peoples, conveniently termed Yellow man, who seem to be more remotely connected with the races of Europe. Even here the degree of divergence is to a certain extent a matter of dispute. Finally, in remote parts of South-eastern Asia there are sporadic traces of an entirely different type of man, who, all ethnologists are agreed, must be considered as widely differentiated from the other two groups.

"In numbers the Negritos are so few as to form an infinitesimal part of the peoples of Asia. Yellow man is very numerous, and probably the greater part of the population of Asia belongs to this race, but the other races are very plentiful and may have slight majority. The smaller varieties of the great stocks are also present in large numbers, although they seem to be divided into certain marked categories. As far as can be judged with evidence that has been collected at present these varieties seem to be dominant in certain well-marked regions, so that in spite of divergencies in detail it is often possible to state in broad outline the physical type which inhabits a certain area. But this can hardly ever be done with the same accuracy as can be attained in plotting the distribution of a language or of a religion. It can never be done with the precise exactitude with which modern nations endeavour to define their political frontiers."

In connection with Dr. Buxton's theme the reader may find it of advantage to consult the article, which evidently was not available to Dr. Buxton, on "The Peopling of Asia" in the Proceedings of the American Philosophical Society, Phila., 1921, LX, No. 4.

It should be added that the volume here dealt with is one of a series on "The History of Civilization" edited by C. K. Ogden. The other volumes of this series already published are: Social Organization, by W. H. R. Rivers; A Thousand Years of the Tartars, by Professor E. H. Parker; The Threshold of the Pacific by Dr. C. E. Fox; The Earth Before History, by Edmond Perrier; Prehistoric Man, by Jacques de Morgan; Language, by Professor J. Vendryes; History and Literature of Christianity, by Professor P. de Labriolle; China and Europe, by Adolf Reichwein; London Life in the Eighteenth Century, by M. Dorothy George; A Geographical Introduction to History, by Lucien Fevre; The Dawn of European Civilization, by V. Gordon Childe; Mesopotamia, by L. Delaporte; and The Aegean Civilization, by Gustave Glotz.

Anthropological Observations on the Anglo-Indians of Calcutta. Part I. Analysis of Male Stature. By Mahalanobis (P. C.)—*Records Indian Mus.*, April, 1922, XXIII, 8°, 96 pp., 4 pl. (Baptist Mission Press, Calcutta).

Elaborate mathematical treatment and discussion of the statures of 200 male mixed-bloods of (generally) English-Indian parentage, taken by or under the direction of Dr. N. Annandale, Director of the Zoological Survey of India, Calcutta, with comparative data from literature.

The anthropological results are summarized as follows: "The more highly civilised races have greater variabilities than the average. This greater variability of more highly civilised races seems to be only moderate in degree and is never excessive. Interracially taller races seem to be more variable than the shorter (both as regards the absolute and the relative variability). Indian Castes and Tribes are significantly less variable than the average. Anglo-Indian variability is greater than Indian Caste variability but is of the same order as the variability of modern European races. The variability of the Anglo-Indian sample though greater than the average is not beyond the range of possibility of homogeneous variability. The Anglo-Indians seem to be rather precocious in growth, and there is some indication of the arrest of growth occurring at an earlier age than in the case of European races. Variability of the smaller age-groups is distinctly less, showing a decrease of variability with time (or increasing homogeneity of the younger generation)."

Physical Characteristics of the Hos of Kolhan. By Majumder (D.)—*Man in India*, 1925, V, 83–114.

Among its increasing and very desirable contributions to physical anthropology, "Man in India" brings herewith a succinct good account of the interesting Hos people of Kolhan, together with the detailed measurements of 200 individuals. The Hos are of "short stature, dark complexion, short broad and flat nose, small but dark eyes, wavy to curly hair, beard or moustaches absent . . . The chin is narrow and the lips are medium. Slight prognathism is noticeable. Ears are small and finely developed. Slanting eyes are scarcely noticeable." The people are in the main dolichocephalic.

It seems to the reviewer that here is one of the number of small remnants scattered over the more southern parts of India which suggest very strongly negritoid origin or admixture.

The Birhors. By Roy (Sarat Chandra)—12mo., Ranchi, 1925, 608 pp., numerous illustr's.

The Birhors "are one of the rudest and least known of the jungle tribes of Chota Nagpur" (to the west of Calcutta). Ethnically they "belong to the same dark-skinned (melanous), short-statured, long-headed (dolichocephalic) wavy-haired (cymotrichous) and broad-nosed (platyrrhine) race to which the Mundas, the Santhals, the Bhumij, the Hos and other allied tribes belong." The total Birhor population in 1911 was 3,085 (1,489 m., 1,596 f.), of which 2,340 in Chota Nagpur; by 1921 the number was reduced to 1,510.

The book deals in the main with the cultural aspects of the tribe. In Appendix III are, however, given a few measurements on 12 individuals which show the cephalic index ranging from 70.6 to 80 and nasal index from 71.4 to 97.7.

Among the photographs a number, to the reviewer, suggest a strong remnant or admixture of negritoid blood.

Collected Anthropometric Data on the Chinese. By Stevenson (Paul H.)—*China Med. J.*, 1925, XXXIX, No. 10, 44 pp.

This is "a report on the Anthropometric data collected by the Research Committee of the China Medical Missionary Association between the years 1915–1925; and an analysis of the heights and weights of the Chinese of North, Central and South China based thereon." The collected data "consist of physical measurements on 10,863 Chinese (9,630 males and 1,233 females), ranging in age from 2 to 70 years, and representing all the different provinces of China." They relate to stature and weight. The conclusions are: "The adult Chinese of North China are taller and heavier than those of Central China; these latter being similarly, though to a slightly less degree taller and heavier than the adults of South China. The Chinese of the South have a definitely shorter growing period and an earlier appearance of the characteristic growth phases, pubescent acceleration in particular, than do the Chinese of Central or North China. Conversely, the Chinese of the North have a relatively prolonged period of growth and a delayed appearance of the growth acceleration characteristic of adolescence. The ratio of weight to height seems to be slightly higher (certainly in adults) in the case of the northern Chinese. The relative changes in this ratio during the various phases of the growth period, however, seem to be the same in the different regions of China. The absolute value of this ratio of weight to height appears to be slightly higher in females than in males. This conclusion must await confirmation in a further analysis of more representative data as far as the females are concerned."

The valuable report is supplemented by numerous tables and curves and, though limited, is sure to be received by all anthropologists with gratitude and wishes for extension of the meritorious work.

On The Cephalic Index and Stature of the Japanese and Their Local Differences. By Matsumura (A.)—*J. Faculty So.*, Imp. Univ. Tokyo, 1925, I, Part 1, Sec. V, 212 pp., 10 pl.

An important contribution to Japanese and probably based on the measurements of 6,000 male and 2,000 female students of Japanese Universities and High Schools.

The author's conclusions are: "The mean values of head-length and head-breadth classified according to provinces vary more in the male length than in the female. The relation of head-length to head-breadth is different for each province, which is perhaps due to the fact that the coefficient of correlation of the head-length with the head-breadth is very small. The Japanese, both men and women, are brachycephalic, the men being slightly less so than the women. The mean values of the cephalic index according to the locality differ from province to province, the local differences appearing, of course, to be more remarkable than in the case of head-length and head-breadth. The Japanese differ from the Ainu and Koreans in head-length, head-breadth and cephalic index with significant differences from the statistical point of view. In so far as the mean values of these characters have been directly compared,

the Japanese appear to resemble closely the peoples of eastern Siberia and South China. The variability in the head measurements of the Japanese differs from province to province, and on the whole, the south-western districts of Japan, which have received the benefits of culture from ancient times are more variable than the other parts, where civilization arrived slightly later. The men have equal variability in both head-length and head-breadth, but in the women the head-length is sensibly less variable than the head-breadth. The men are more variable than the women in both head-length and cephalic index, and less so as to head-breadth. With regard to the cephalic index, however, the sexual difference is so very small that neither sex can be said to be more variable than the other. The Japanese are less variable than the Koreans in head measurements in both sexes, but sensibly more so than the Ainu. However, in regard to the cephalic index, the Japanese have a smaller value than the interracial variation obtained from measurements on living subjects.

It appears that the stature of the Japanese men and women has, for the last ten years at least, shown a tendency to increase slowly. The stature also varies according to provinces, but not so remarkably as in the case of the cephalic index. The relation of stature to the cephalic index is also different for each province. This was to be expected from the fact that the coefficient of correlation of stature with the cephalic index is very small. Statistically, the Japanese differ from the Ainu and Koreans in stature. So far as the mean values of stature have been directly compared, it has been found, as in the case of head form, that the Japanese closely resemble the peoples of eastern Siberia as well as those of South China and Indo-China. The variability in stature of the Japanese classified according to provinces also varies, and its fluctuations correspond, taken one with another, with those of the cephalic index. In stature the men are distinctly more variable than the women. The Japanese are much more variable as to stature in both sexes than the Koreans, but very sensibly less so than the Ainu.

"The correlation of the head-length with the head-breadth of the Japanese is low positive, and that of stature to the cephalic index is low negative. Investigating the local differences of the cephalic index and stature by examining whether the difference between two means for each two provinces is significant or not, all the provinces are classified into four groups for the former and into three for the latter. By combining the cephalic index and stature grouped respectively in the manner described above, the Japanese are classified in nine different local groups."

ETUDE ANTHROPOLOGIQUE SUR LES NEO-CALÈDONIENS ET LES LOYALTIENS. By Sarasin (Fritz)—*Arch. suisses d'Anthrop. gén.*, II, Nos. 1 & 2, 1916–'17, 83–103.

The author's studies show that, while related, the New Caledonians and Loyalty Islanders present nevertheless certain differences; and that each group shows also appreciable locality differences within itself.

It is not yet possible to decide whether these differences are due to mixtures or are local developments. The valuable data give the essentials of the author's measurements and observations. The main measurements follow:

	New Caledonians.				Loyalty Islanders.			
	Males.		Females.		Males.		Females.	
Stature	(250)	166.4	(65)	156.6	(91)	167.7	(39)	156.5
Cephalic Index, living skulls	(185)	*76.5*	(50)	*76.7*	(87)	*72.5*	(38)	*73.7*
	(102)	*71.8*	(62)	*71.2*	(both sexes:		61 =	*71.4*
Facial Index, morphological	(180)	*80.4*	(50)	*78.8*	(87)	*83.1*	(38)	*81.8*
Nasal Index	(183)	*99.3*	(50)	*98.1*	(87)	*91.5*	(38)	*92.3*

The glabella and ridges are strongly developed in both groups. The hair is spiral ("helichotrichous"), beard rather abundant, body (males) covered more or less profusely with black curling hair. In children up to 1½ years however, the hair is nearly straight to lightly wavy, brown to light-brown in color (in instances even blond), of fine texture and rounded on crosscut (index 88). The body is lightly covered with fine hair of yellowish color.

A complete report of this deserving work is to follow.

THE MULATTO PROBLEM. By Dodge (Ernest)—*J. Heredity*, 1925, XVI, No. 8, 281–'6.

"In the United States a problem exists which demands extensive and impartial eugenic research, but which unfortunately has never received it on any adequate scale. Nine-tenths of our population are a heterogeneous mixture of many Europeans races which collectively we call by the misnomer of 'Caucasian'. The other one-tenth belong to a type so different and so prepotent for perpetuating their differences in mixed offspring, that present-day sentiment is strongly crystalized against amalgamation of the two populations" (white and negro). "The present article is meant in part as a plea for the endowment of scientific research" and an indication of some of the ways.

SOME LITTLE KNOWN TRIBES OF THE SOUTHERN SUDAN. By Seligman (C. G.)—*J. Roy. Anthrop. Inst.*, 1925, LV, Jan.–June, 15–36.

"On the White Nile, directly south of the Dinka boundary, there is an immediate rise in cephalic index to mesaticephaly on the west bank, while on the east bank this does not occur until south of the Bari. In the Bahr el Ghazal province mesaticephaly prevails immediately west of the Dinka. Here the great mass of southern mesaticephals is divided from the mesaticephalic Nuba of southern Kordofan only by a zone of immigrant Arabs. It may then be suggested that this whole mass of mesaticephals be regarded as constituting an ethnic unit, using the term in a broad sense (perhaps as broad as that in which we speak of the roundheads of Europe and Hither Asia). On the cultural side the most obvious common character of importance is that Nuba and southern brachycephals alike use rainstones to produce rain. Within the mass of southern brachycephals there has been a movement from west to east,

which in the latitude of the Bari-speaking tribes has been checked by the counter-pressure of tribes speaking dialects belonging to the Masai group. This counter-pressure is most obvious in the country of the Bari proper and of the Lotuko-speaking tribes lying east of them, among whom it has kept the cephalic index within the limits of dolichocephaly, though it has not prevented these tribes taking over the use of rainstones from their western neighbors. Using language and rainstones as guides, it is possible to reconstitute the history of the Acholi (and probably, at least, of some other tribes speaking Shilluk dialects) and to account alike for their mesaticephaly and their cultural differences from the Dhilluk."

Notes on the Physical Anthropology of Certain West African Tribes: (2). The Tribes of the Grassland Area, Central Cameroon. By Malcolm (L. W. G.)—*Mitth. d. Anthropologisches Gesellsch. in Wien*, LV, repr. 8°, 45 pp. Vienna, 1925.

"The present paper is part of work in progress on the physical anthropology of the tribes of West Africa, and deals with the semi-Bantu tribes in the Grassland area of the central Cameroon. The first communication was concerned with certain physical characters of the Munci tribes of Northern Nigeria (Munci Man, *ibid.*, 1920, XX (8) No. 60, 116–121) . . . "The Egāp is a small tribe belonging to the Tikar group of tribes in the grassland area of the Western Cameroon, and has probably reached its present location from the east or north-east. By reason of certain external influences, such as the importation of women from other areas, and slavery, the homogeneous character of the tribe has been altered considerably, even within the past few years. At the time when the observations were being recorded women were imported from Bamum. Not far from this tribal area are the Wute and other Tikar tribes. The former are in contact with pygmies, so it is more than certain that pygmy blood will be found in a number of the western semi-Bantu tribes. As far as the males of the tribe are concerned the results show that they are mesaticephalic with a strong tendency towards brachycephaly; hypsicephalic, hypereury- to euryprosopic; euryenic with a strong tendency towards meseny; medium statured and low spanned."

The Northern Tribes of Nigeria. By Meek (C. K.)—8°, 1925, 2 vols., pp. 312, 276, numerous illustr's, 3 maps. (Oxford Univ. Press, Amer. Branch, N. Y., $12.00.)

The two well printed and amply illustrated volumes constitute a valuable treatise of ethnography on the tribes of the Northern Provinces of Nigeria. They are based partly on reports rendered to the Government (British) by various administrative officers, but in the main on the author's observations in the field. They deal with the following subjects: Volume I—General Description; Ethnic Types; History and Tradition; Economic Life and Industries; Social Organization; Govern-

ment and Law. Vol. II—Religion; Language and Lore; Ethnological Conclusions; and The Census.

The items of special interest to physical anthropology are the numerous photographs of the natives; the maps; sections on Climate, Anthropogeography, Racial Elements, Prehistory, External Influences, Marriage, and the Census data.

As to prehistory, curiously "there is seeming absence of early paleolithic culture in Nigeria. From the Sahara, as elsewhere in Africa (*e. g.* Somaliland and South Africa), many stone axes of the palaeolithic age have been discovered . . . But in West Africa generally there is a remarkable absence of palaeolithic specimens."

As to the census, "The area of the Northern Provinces is 254,237 square miles, the total population is 9,998,314, and the average density is 39.33 persons per square mile."

The photographs in various instances carry a suggestion of Arab admixture.

La prétendu parenté des négroides Européens et des Boschimans. By Verneau (R.)—*L'Anthropologie*, 1925, XXXV, 235–264.

No remains of prehistoric man have been so sinned against as, on the one hand, those attributed to the Cro-Magnon "race," and on the other those of the Grimaldi "negroids." As well known, one of the Menton (or Grimaldi) caves gave among other bones two skeletons the skulls of which show apparently negroid features. Basing themselves upon this, and on the representation of steatopygy, (which erroneously is supposed to be peculiar to the Hottentot and Bushman) in the prehistoric human "Venuses," some authors first of all made another race of the negroid Grimaldi skulls and then attributed them more or less confidently to the same physical stock that gave us the Bushman. Professor Verneau, on the basis of important cranial (and other) measurements, particularly the height of the vault, shows that "the skeletons of the Negroids of Grimaldi have not the slightest relation with the Bushman . . . The theory of the common origin of the two [Grimaldi negroids and Bushmen] based on pretended resemblances of the two groups, is simply a hypothesis which does not stand an impartial examination of the facts." The problem of the origin of the Grimaldi negroids "still awaits its solution."

RACIAL CRANIA

Das Hockerskelett von Ursisbalm bei Niederried (Kanton Bern). By Schlaginhaufen (Otto)—*Jhrb. Bern. Hist. Mus.*, IV, 1924, 14 pp.

Description and measurements of a neolithic female skeleton. Stature very moderate (estimated at 148.7 cm.), skull on the border of dolichocephaly (C. I. 75.2), type agreeing in general with the prevalent neolithic.

(The Prehistoric People of Bohemia. In Czech; Abstract in French.) By Stocký (A.) and J. Matiegka—*Anthropologie*, (Prague), 1925, III, No. 2, 138–155.

The authors will endeavor in a series of articles to give whatever data may be possible on the physical characteristics of prehistoric occupants of Bohemia from the Neolithic onwards. The first report here published deals with the later neolithic "people of the bell-beakers," once a widespread culture of southwestern and central Europe. The authors find that this culture in Bohemia was associated with two distinct types of people; one, older, morphologically still somewhat primitive, of taller stature, mesocephalic, with low vault, narrow face and nose; the second shorter, brachycephalic, with high vault, medium breadth of face and broader nose.

(Crania and Skeletons From Mounds of the Period of the Moravian Empire.) In Czech; Abstr. in French. By Červinka (J. L.) and J. Matiegka—*Anthropologie*, Prague, 1925, III, No. 2, (Memorial Number to Prof. L. Niederle), 97–198.

A discovery of a series of old Slavic skeletons from about 800 A. D. shows once more that originally the Slavs were in the main dolicho- and hypsicephalic, with long face and other characteristics approaching them closely to the "Reihengräber" type. The change from this type to that of the present marked by brachycephaly, has now been documented by numerous finds both in- and outside of the boundaries of the Czechoslovak Republic, and is a phenomenon of much consequence in anthropology.

(Crania and Bones From Old Cemeteries in Prague. In Czech, with résumé in French.) By Matiegka (J.)—*Anthropologie*, 1924, II, Nos. 3–4, 183.

The foremost Czech anthropologist gives the essential data on 115 male and 55 female adult Czech skulls from the XIII–XVII centuries. Main results: *Capacity*, m. 1405, f. 1295 cc. (similar to that of skulls from Czech ossuaries of the XVIII century); *Vault*, male, l. 17.95, b. 14.95, bas.-bg. h., 13.27, C. I. *83.4;* fem. l. 17.31, b. 14.41, h. 12.83, C. I. *83.2; Face*, h. morphol., male 6.84, fem. 6.37; b., m. 13.11, f. 12.7; F. I. morph., m. *50.75*, f. *50.75;* Nasal index, m. *50.1*, f. *47.4;* Orbital index, m. *84.7*, f. *87.—*.

(Types craniologiques de la Pologne.) In Polish; Abstract in French. By Stojanowski (Karol)—Kosmos, 1924, XL, 660–766.

The tendency to reduce anthropology to the simple and definite order of geometry and mathematics, recurs again and again on the part of workers who are still full of the optimism and resistlessness of scientific youth. It is only later, much later, that they are bound to acknowledge that nature, with man especially, works on no easily delimitable grooves, but with unbounded complexity an understanding of which we may here

and there approach but can neither fully reduce nor fathom. The author has measured a series of Polish skulls and utilizing twelve indices of these together with skull capacity, and with additional data obtained from literature believes himself justified in advancing the following main conclusions: With the aid of the method of "differential analysis" it is possible to decompose every population into a number of cranial types that correspond strictly to anthropological types. These types, very durable, reach far into the past. The number of these types is limited and strictly defined. Every skull can be described and defined as to its race. And having now this "key" we can not only apply it to solving the anthropological riddles of the present but also those of the past . . .

This, as with Dixon, Sergi, some of the modern biometricians and earlier phrenologists is an attempt at anthropological mechanics which are to do away with our difficulties. The trouble or one of the troubles is that all these panaceas ignore nature.

A Note on the Physical Characters of the Prehistoric Kansu Race. By Black (Davidson)—*Mem. Geol. Survey China*, June, 1925, Ser. A, No. 5, 52–56.

A study of the prehistoric skeletal remains from the Kansu sites, leads the deserving author to the following conclusions: "The general impressions gained from a preliminary survey of the human skeletal remains from the prehistoric sites of Kansu are such as to indicate that the inhabitants of this region were probably largely of proto-Chinese type and not as Professor Karlgren suggests of Turkish race, while among the earliest inhabitants known by their skeletal remains, a few individuals occur belonging to an allied and possibly more archaic type."

The Human Skeletal Remains From the Sha Kuo T'un Cave Deposit in Comparison With Those From Yang Shao Tsun and With Recent North China Skeletal Material. By Black (Davidson)—*Palaeontologia Sinica*, 1925, Ser. D, I, Fasc. 3 (Geological Surv. of China, Peking).

A thorough, well documented and handsomely illustrated volume, with a large abstract in Chinese, in which the author describes interesting aenolithic and recent skeletal material from northern China. Regrettably many of the crania were in poor condition. For the many morphological observations it will be necessary to consult the original. As to the anthropological value of the material, it is difficult to "avoid the conclusion that the Sha Kuo T'un and Yang Shao peoples conformed to a type essentially similar to that represented by the present day North Chinese with whom comparison has been made. At the same time departures from this common type evidently characterize each of the three groups, though these differences would appear to be no greater than those distinguishing from one another the different groups of North American aborigines with whom comparisons have been made in the body of this report."

Contribuicao para o estudio anthropológico de Timor. By de Lima (J. A. Pires) and Constáncio Mascarenhas—*Arquiv. de Anat. e Antrop.*, Porto, 1925, IX, 451–467.

A description of four crania from Timor, together with a review of former contributions to the anthropology of this island. In harmony with other students the author concludes that the population of the island is a mixture of malayan, indonesian and one or more negroid elements.

Six Hitherto Undescribed Skulls of Tasmanian Natives. By Wood-Jones (F.); With an Account of the Palate and Teeth. By T. D. Campbell—*Records So. Austral. Mus.*, 1924, II, No. 4, 459–469.

Without entering upon comparisons or critical consideration of the material, the authors give the more important cranial and dental measurements and observations on two Tasmanian crania in the possession of the South Australian Museum, Adelaide, and on four similar specimens at that time in possession of Dr. Robert Pulleine, of the same city. The carefully recorded data will be welcome by students of the subject.

On the Existence of a Dolichocephalic Race of Gorilla. By Bolk (L.)—*Proc. K. Akad. Wetenschap. Amsterdam*, 1925, XXVIII, No. 2, 205–213.

"Among the present living Gorillas, a race is found which is strongly dolichocephalic and leptoprosopic and shows both these qualities to the same high degree as the fossil of the Australopithecus . . . Amongst the 50 Gorilla skulls in the Anatomical Museum of the University of Amsterdam only one example of this race is present. This skull is conspicuous on account of its outstanding difference from the rest . . . The skulls present in the above-named museum are partly derived from Camerun and partly from the French Congo." The "encephalic" (endocephalic) index is used. It varied in 10 other gorilla skulls between 80.6 and 86.9, in the peculiar specimen it was 72.4. The morphologic facial index which in 43 other gorilla skulls ranged from 103.4 to 122.6, in the dolichocephalic individual is 89.5. The capacity of the latter is 550 cc., that of the 27 other males in the collection extends from 450 to 655 cc. Finally the sexual (male) characters of the skull are subdeveloped.

THE AMERICAN INDIAN

Les origines de l'homme Américain. By Rivet (P.)—*L'Anthropol.*, 1925, XXXV, 293–319.

Basing himself mainly on some linguistic and cultural resemblances, the author decides that "we now possess certain proofs that four elements have entered into the formation of the American Indian." They are: the Australian; a Malayo-Polynesian element by language but attached by its physical characteristics to the Melanesians; an Asiatic element "without doubt the most important, which has given to the whole of the

aborigines of the New World a certain uniformity of external appearance;" and a Uralian element represented by the Eskimo. And the author is by no means certain that this is all.

The linguistic and cultural resemblances or parallelisms that have been made to serve for this extraordinary theory will doubtless be dealt with by competent authorities elsewhere. So far as physical anthropology goes it can only be said that the adduced proofs considered in as friendly a spirit as may be, fail to carry conviction. European scholars work under many difficulties when dealing with American problems.

Les Australiens en Amérique. By Rivet (P.)—*Bull. Soc. Linguistique*, XXVI, 43 pp.

This paper, like the one on American Origins by the same author, is based in the main on apparent linguistic resemblances, and while in the latter Dr. Rivet inclines to bring the Melano-Polynesians to California, in this one he essays to show that the Australians reached Tierra del Fuego and Patagonia. He evidently regards the linguistic indications as both well founded and sufficient to prove direct immigration. The Australians in his opinion reached South America by the sea, and that about 3,000 years ago.

Were these rather revolutionary views expressed by a less known student than Dr. Rivet they would probably command but little attention; as it is we cannot but feel that Dr. Rivet must also possess ample and decisive proofs for his notions in the lines of physical anthropology and their fullest possible publication will be confidently awaited.

The Rappahannock Indians of Virginia. By Speck (Frank G.)—*Indian Notes & Monographs*, Mus. of the Am. Indian, V, No. 3, N. Y., 1925.

"While the existence of two Indian tribes, the Pamunkey and the Mattaponi, in tidewater Virginia has been more or less generally known, there has remined an almost total lack of information concerning the existence of other bands of descendants of the original Powhatan tribe . . . It appears that at least ten mixed groups exist in the same general localities where their ancestors lived . . . Probably none of the numerous persons of Powhatan Indian classification in the state could now boast of absolutely pure Indian blood—."

The Rappahannocks count approximately 500 individuals. All of those shown in the illustrations plainly show greater or lesser amounts of white blood. Their physical characteristics will be dealt with in a later report. A remarkable feature is that these Indians "have retained a custom which I was surprised only a year or so ago to encounter first among the Chickahominy, namely, that of artificially flattening the occiput of infants. This is done by means of a small, rather stiff pillow stuffed with corn husks, placed beneath the child's head when it is put to sleep. The child is then induced to repose upon its back, being turned over when it happens to roll over on its side. The Virignia Indian de-

scendants who practice this operation assert that it is done to make the head beautiful. At the same time the mother pinches the infant's nose to make it long for the same reason."

An Introduction to the Study of Southwestern Archaeology. By Kidder (Alfred Vincent)—New Haven, 1924, 4°, 151 pp., 50 pl. 25 fig's in text (Yale Univ. Press).

A finely printed and richly illustrated work, giving account of years of fruitful excavation in the ruins of the Southwest, particularly in the Pecos valley. The author deals in the main with archaeology, but includes a record of the finding and careful preservation of many hundreds of human skeletons, and draws conclusions some of which are of direct interest to the physical anthropology of the Pueblo region. To which is added a rich bibliography on exploration in the Pueblo and neighboring regions.

Skeletal Remains From Santa Barbara, California. I. Craniology. By Oetteking (Bruno)—*Indian Notes & Monographs*, Mus. of the Amer. Indian, N. Y. No. 39, 1925, 168 pp., 12mo., 32 pl.

A conscientious piece of work on five crania of the Burton Mound at Santa Barbara, California, three of which were discovered in 1923 by J. P. Harrington and claimed at first to represent a man of great antiquity. After studying the skulls minutely the author reaches the following conclusions: "The designation of the Santa Barbara finds as a special variety of *Homo primigenius* (in Schwalbe's sense) and under the caption of *Homo barbarensis* or the like, is unjustifiable; nor do they present an assemblage of such morphological features as to warrant their recognition as a special racial unit within the ethnic complex of which they form a part. The Santa Barbara crania, in spite of their slight primitiveness, are truly Indian, of recent morphological appearance, and are related to the types of their specific habitat."

The photographs show clearly the well-known native cranial type of the region. The report is well illustrated and supplemented by a good bibliography; but the index is not as full or easy of perusal as would be desirable. The study of the remaining parts of the skeleton is to follow.

Indice craneometrico de los Indigenas prehispanicos y actuales de la Mesa Central de Mexico. By Pauer (Paul Siliceo)—*Anal. Mus. Nac.*, Mexico, 1925, I, No. 4, 338–343.

The author discusses the cranial type of the population represented in the Valley of Mexico by the archaic culture, and reaches the following conclusions: "In precolonization times there existed in the Valley of Mexico three indigenous groups: The Otomís or archaic, the Teotihuacan, and the Aztec. The first were dolicho-, the second brachycephalic." The modern representatives of these three groups, however, are mesocephalic, which indicates crossing.

Cultura postneolitica del Pedregal de San Angel. By Lozano (Enrique Diaz)—*Ethnos*, (Mex.), 1925, I, 25–35.

A very creditable discussion of the age of the remains found under the lava cap in the "pedregal" of San Angel. The author deals only with the cultural phase but what is true of this has a direct bearing also on the skeletal remains found in the locality. He concludes that the age of the remains and that of the archaic culture in general is "post-Neolithic." Under the lava the remains lie on what are probably Pleistocene deposits, but in these no trace of man has been discovered.

The Punin Calvarium. By Sullivan (L.R.) and Milo Hellman—*Anthrop. Papers Am. Mus. Nat. Hist.*, XXIII, 1925, 313–324.

In November 1923 H. E. Anthony, Associate Curator of Mammals, American Museum of Natural History, discovered an interesting human calvarium in Quebrada Chalan, Punin, Ecuador. The skull lay "in a low bank directly over the watercourse of the Quebrada Chalan, down which a trickle of water flows normally but which is subjected to torrential violence when rains are heavy . . . The bank at this point is about six or seven feet high and the ash rests upon a floor of syenite which is swept clear by the water. Consequently any bones that might be weathered out of the bank would be carried on down the quebrada by the first heavy rain. Most of the ash strata are compacted into a tuff, a tough, semi-elastic formation, but where the calvarium was found a slow seepage has prevented this packing down of the ash and the formation is looser as well as quite damp to the touch. The skull was so damp when it was removed that it was exceedingly friable and broke under its own weight. After it had dried out in the air the texture of the bone became fairly dense and quite comparable with the bones of horses, camels, mastodons, etc. found in the quebrada. While the remains of the Pleistocene mammalia are scattered up and down the Quebrada Chalan for many hundreds of yards, there are intervals where no bones may be found although these gaps are not very extensive. The human cranium was found in one of these intervals and for this reason its association with horse, camel and mastodon cannot be asserted as an incontestible inference." Several photographs show nicely the location of the specimen.

The authors see in the specimen "clearly a *Homo sapiens* no more closely related to *Homo primigenius* than many other modern races," but show that it presents a general resemblance to the Australoid type. They conclude however that "It is quite possible that if we had the mandible and other parts of the skeleton our decision might be different. We wish to emphasize particularly the point that in claiming that this calvarium is Australoid we have in mind a basic racial relationship and we do not believe that it necessarily represents migration from Australia or Melanesia. We feel that unless this is indeed a very remarkable case of parallelism, this type in America and the similar type in Australia and Melanesia are derivations of the same basal racial stock."

The reviewer wishes in general to warn against premature conclusions and hypotheses in this connection.

CORRESPONDENCE AND NOTES

Tertiary Man in Portugal

Last June I received a letter from Mr. F. Raposo, from Carregado (Extremadura), telling me that in the Quinta (farm) das Lages, near Ota, Alemquer, while some diggings were being done, there had been found by the farmer, Mr. H. Cabaço, some human teeth and bones, together with some shaped flints, and that the remainder had been left *in loco*, awaiting my visit for a methodical search. It was soon thought by some that we were dealing with remains of the Tertiary man, as the soil appertains to the lacustral Miocene, and lies within the region where Carlos Ribeiro and Nery Delgado discovered the celebrated *eoliths*, which Mortillet attributed to the hypothetical *Homosimius Ribeiroi*.

The chemical analysis of some splinters of bone that were sent me showed still about 18% of organic matter, and among the shaped flints that I received by the same occasion, there was one of trapezoidal shape, of *tardenoisian* type. It was therefore with heavy doubt, about the Tertiary age of the finding that I went on the 9th. of August to preside over the search of the site. We were only dealing with burial remains, from the inicial Neolithic, 60 centimeters deep, dug in a layer of calcareous sandstone belonging to the lacustral Miocene. There appeared at the same level some more fragments of bone, teeth, flints, (among which were also trapezoidal) and a polished axe.

The skeletal remains were mixed, very friable and nearly all reduced to very small fragments. His study allowed me to suppose that they belong to more than one person. The length of a femur partially restored agrees with a tall stature. Some bones and teeth should belong to a strong adult man.

In the vicinity of Ota we have gathered, in some trenches recently dug, some *eoliths*, of small size, similar to those of Ribeiro.

Had the search of this layer of Quinta das Lages not been done with method and scruple, it would be no wonder if in paleo-anthropologic literature a new pretended Tertiary skeleton should have made its appearance. As soon as I can I will write a fuller note on the subject.

A. A. Mendes-Correa, *Univ. of Porto*,
Nov. 14, 1925

Early Man in Moravia

Moravia, the agriculturally as well as otherwise rich central part of Czechoslovakia which for many years past has been yielding cultural and skeletal remains of early man (jaws of Šipka, Ochoz; skulls of Brno, skeletons from Předmost), is since the war rapidly assuming an ever greater importance in this field.

Within the last two years the finds have been enriched by three major stations of Aurignacian man. The first of these is that at Vistonice, southern Moravia. This, as shown by the energetic excavations of Dr. Karel Absolon, Curator of the Zemské Museum at Brno, in 1925, is one

of the greatest if not the greatest, of known stations from the Aurignacian period. It extends along the foot of a moderate-sized elevation under a thick layer of loess. It has already given a great quantity of specimens, cultural and palaeontological (mammoth, rhinoceros tich., etc.). It contains a whole "cemetery" of mammoth bones. As yet it has yielded no skeletal remains of man, but the full extent of the site is still unknown and there is substantial hope that human burials will be encountered. The wealth of the site in specimens is such that during last year Dr. Absolon removed over 70 cases of these to the Museum at Brno.

The second large Aurignacian site is that at Předmost, in central Moravia. This station has been known for perhaps 50 years and gave already vast collections, including 18 human skeletons, but was since long thought to be exhausted. During 1925 excavations in connection with nearby brickworks revealed that the site extends much farther, and that together with what had already been excavated it doubtless rivals if not exceeds that at Vistonice.

Still another highly promising Aurignacian site has recently been located in the course of some engineering works in northernmost Moravia near the large manufacturing centre of Vítkovice.

All these stations belong evidently to the later Aurignacian, may be roughly contemporaneous or nearly so, and are according to all indications very similar to another very large and as yet barely touched Aurignacian site near the village of Myzen in the Ukraine.

Excavations in the above-mentioned Moravian sites will be carried on during 1926 under the direction of the Czechoslovak Archaeological Institute and the Museum in Brno and suitable government appropriations have already been made for that purpose. The results of this meritorious work will be eagerly expected and will doubtless throw much new light on the important period which they cover.

In addition to these large sites there are now known in Moravia approximately 70 other sites of Palaeolithic man. Some of these, according to indications, date much farther back than the Aurignacian.

A. H.

Light Hair in Australian Aborigines

During his 1925 trip to the far South-East, including Australia, the writer has come across a highly interesting phenomenon that calls for elucidation. It is the occurrence of light hair in full-blood natives. The first case was that in a female child a year and a half old, at Derby on the north-western coast. It was the second child of a young couple, both ordinary full-bloods, in the service of the local Protector of the Aborigines. The father's hair was black, the mother's brown-black. The first child, a boy, four years old was also quite ordinary with brown-black hair like the mother. But the baby, without in any way suggesting a mix-blood had hair that was decidedly lighter brownish. The local doctor, who knew the family well, as well as their master and mistress, felt sure that neither the child nor the parents had any white blood. No one had any explanation of this and it did not seem to be regarded as

anything very strange. Other natives (about 40 adults) seen at Derby showed nothing special in this respect.

Some time afterwards the writer had a chance to see two groups of natives along the railroad between Koolgarie and Adelaide. The first group consisted of 7 women, 5 men, a boy and a small child. In the child the hair was of a ginger color, or of a yellowish-dirty wool, but there was some brownish-black later hair nearer the skin. In two of the women the hair was also not fully black (lustreless brownish black), but all were full-bloods according to all indications.

The next and larger group was seen near the desert station of Ooldea. In this group there were 18 natives, men, women and children, with one possible exception all apparently full-blood, but with hair in quite a few of the children and girls approaching the dull yellow of crude sheep's wool, or that of a rope, tow or ginger, ranging to brownish black in some individuals. None of the adult men or older women showed the condition. One girl of about twelve had a particularly fine head of ginger hair but would not give a sample.

Later on it was learned, particularly from Dr. Herbert Basedow of Adelaide, that hair of this nature is well known to occur among full-blood Australian aborigines, though the subject has never been studied; and it was possible through the kindness of Dr. Basedow to secure both a sample of the tow hair and a photograph showing three young adult "gins" (women) with such hair.

In all cases that come to the notice of the writer the tow or ginger hair was associated with ordinary full-blood features and brownish-black skin color. Fairly numerous mix-bloods seen in Adelaide and on the Murray had in no instance hair of or approaching this character. Light hair has however been reported in Australian mix-bloods (Ch. Chauvin-Deuxième rapport à M. le Ministre de l'Instruction publique sur les aborigènes de l'Australie. *Arch. des Missions scientifiques*, Melbourne, 1880, VII, 481–2): "Parmi les enfants de sang mêlé, il n'est pas rare de rencontrer des cheveux châtain clair à reflets cuivrés. Une métisse de deuxième sang les avait même tout à fait blonds."

In no case of the tow hair was there any nystagmus, or light colored iris, or any other indication of albinism. The condition is not albinic.

The writer's repeated impression on seeing the lustreless tow hair was that it looked as if it had been bleached. It is akin to the peroxide hair. But repeated inquiries, with natives and whites, discouraged this view. The natives on occasion work ochre or mud into their hair and the results may possibly be some discoloration, but this would scarcely proceed above rusty black. The Rev. John Mathew's observation on unmixed aborigines (*Trans. and Proc. Roy. Soc. N. S. W.*, 1889, XXIII, Part II, 343–4) may be of interest in these connections. He says: "The occurrence of strongly contrasted complexions, copper and almost jet black in the same tribe is exceedingly common. Some of the fairer skins are accompanied by light-colored hair whether faded or natural. At Beemery Station, between Bourke and Brewarrina, the family of the leading black were very fair and had long straw-colored hair. I have

heard of similar cases elsewhere, and have known one or two in southern Queensland." And Spencer and Gillen, writing of "The Native Tribes of Central Australia" (8°, Macmillan and Co., Lond., 1889, 38–9), have this to say: "The color (of the hair) is usually jet black, though the presence of abundant red ochre may at first sight cause it to appear to be of a more brownish hue, and occasionally it is of a dark brown tint rather than jet black. Amongst the children there are now and then met some whose hair is of a decidedly lighter color, but the lightness is confined to the tips, very rarely reaching to the roots, and with the growth of the individual it usually, but not always, assumes the normal dark color." Even a better account is found in the "Report on the Work of the Horn Scientific Expedition to Central Australia," (Lond. and Melbourne, 1896, Part IV, 17–18): "Almost in every camp but most frequently at Tempe Downs, the hair of some of the children was, in marked contrast to the usual dark hue, of a very light tawny or almost tow color, and wherever this coloration existed it was most marked at the tips, though in some cases it extended to the roots. The peculiarity appeared to be quite independent of any artificial bleaching and was not of very frequent occurrence. As all natives have their hair equally exposed to the weather it is not easy to account for this exceptional feature."

The condition is evidently a generalized one, to be found in all parts of the continent. It may be related to the transitory presence of light hair in the children of the Loyalty Islanders recently reported by Sarasin (see "Literature" this number), but it is more lasting, though seemingly not absolutely permanent, in the Australian. Just how frequent it is in the Australian child and later, whether it is limited to or more common in females, and just what it means phylo- and ontogenetically, are interesting points to be determined.

Aleš Hrdlička.

Variation

Boulder, Colo.
December 30, '25

Dear Dr. Hrdlička:

Regarding very interesting discussion in your Journal of Phys. Anthropology don't you think the trouble is, you *asked* for a *definition*, whereas you *wanted* an *explanation*—a very different matter!

And as for the explanation—well, read Tennyson's "Flower in the Crannied Wall!"

Yours
(Sgd.) Thos. S. A. Cockerell

The quotation in question is as follows:

Flower in the crannied wall,
I pluck you out of the crannies,
I hold you here, root and all, in my hand,
Little flower—but *if* I could understand
What you are, root and all, and all in all,
I should know what God and man is.

Determine Sex by Blood Tests

A simple chemical test by which sex can be determined with reasonble accuracy has been developed by Dr. Dewey G. Steele, and Dr. Agnes Zeimet, working at the University of Wisconsin. The blood test has been applied to cattle and birds, and it works also on human beings. In an accuracy trial, 20 pigeons were placed in the proper category out of 20 tried; of 77 fowl, 63 were ranked with the correct sex; and with 17 cattle there were no errors. The test is doubly sure with poultry, as the feathers have been found to give an additional, but reversed reaction. Using this criterion of sex, poultrymen can kill off the useless males early in life Dr. Steele said. While emphasizing that the technic is still in the laboratory stage, Dr. Steele indicated that the test might be of use in criminology and in showing the sex of unborn children. The test may also be of use to biologists, in order to reveal body changes following the transplantation of male sex glands. The procedure in the case of cattle consists in adding hydrochloric acid and an oxidizing solution to a test tube sample of serum, diluted 100 times, of the animals to be examined. Four drops of methyl green dye are then introduced, whereupon serum taken from females gives a green color, and that originating in males, a red. The explanation of the reaction is a difference in the appetite for oxygen of the serum from males and females, in Dr. Steele's opinion. A cumbersome test, requiring 5 chemicals and complicated by a time factor, is being used in Russia with some success to forecast sex in pregnancy, the biochemist states.

Sci. Serv. Letter, **Feb. 1, 1926**

A new *Society for Physical Anthropology* has been founded in Germany under the chairmanship of Professor Aichel-Kiel. According to *Eugenical News*, on motion of Professor Aichel, Professor E. Fischer of Freiburg was elected president, and Dr. W. Gieseler, secretary. The new society will work in harmonious relations with the old "Gesellschaft für Anthropologie, Ethnologie and Urgeschichte" but will support more especially physical-anthropological investigations in Germany. The first meeting of the new society will take place at Easter time, 1926, simultaneously with the anatomical meeting in Freiburg.

Science, **Nov. 27, 1925, 491.**

New Journal. As its fifth offspring, the Viennese periodical "*Die Quelle*" has begun to issue, under the direction of Dr. Karl Lang a semipopular monthly called "*Völkerkunde*." The new journal will occupy itself essentially with ethnology, but also with human geography and other lines of studies of interest to physical anthropology. (Subscription, 5 shillings per year; Address: Dr. Karl Lang, Wien IV, Argentinievstr., 47.)

The *Anthropologische Anzeiger* founded in 1924 by Rudolph Martin, will continue to be published in connection with the "*Anthropologisches Institut*," Neuhauserstr. 51/iii, Munich, Germany.

New Journal. Beginning with January, 1926, there will appear "*The Quarterly Review of Biology*" (8°, Williams & Wilkins Co., Baltimore). The Editor-in-Chief is Professor Raymond Pearl. There is an "Advisory Board," on which Professor A. L. Kroeber represents Anthropology.

The Review "proposes to publish the results of recent studies in the several fields of Biology in accurate and interesting form. The papers published will present the current status of the various phases of Biology: Anatomy, Anthropology, Behavior and Comparative Psychology, Botany, Cytology, Ecology, Embryology, Experimental Morphology, General Physiology, Genetics, Geographical Distribution and Taxonomy, Paleontology and Zoology. The articles will be short but comprehensive, written so far as possible in non-technical language so that teachers, investigators and other persons who are not actively engaged in research but who are interested in Biology in its broader sense, can readily understand papers by specialists working in other fields . . . The subjects and authors of all articles published will be selected by the Editor, Associate Editor and Advisory Board. This procedure assures readers of accurate and timely articles."

The regular subscription price is $5.00 a year, postpaid, but a "Charter Subscriber" rate of $4.00 a year will be allowed to subscribers who forward their orders prior to March 1, 1926.

The Japan Dental Journal, Vol. 1, No. 1, March, 1925, established and edited by Professor Mitsuru Okada and published in both Japanese and English, brings the following articles of interest to Physical Anthropology: The Relation of Tooth Extraction and Dental Caries of the Stone Age Race in Tsukomo and Ko, by Kikutaro Ogushi; Changes in the Development of Teeth resulting from Extirpation of Thyroid and Parathyroid Glands, by Nobuyasu Ikuta. The number brings also a translation into Japanese of Hrdlička's "New Data on the Teeth of Early Man and Certain Fossil European Apes (from the *Am. J. Phys. Anthrop.*, VII, No. 1, 1924), Dental Notes and News, and Notes on the Transactions of the Dental Associations in Japan."

The First American Health Congress. For the first time in the history of public health in America those who are doing the work itself will have a chance to meet together and view it as a whole when the American Health Congress convenes in Atlantic City May 17–22.

To address the opening session, Sir Arthur Newsholme, who has been highly successful in the development of public health work in England and who also has a close knowledge of the American public health situation, is visiting this country. Professor C. E. A. Winslow, President of the American Public Health Association, will address one of the general sessions of the Congress. "Is Public Health improving the Race?" is the title of the address to be delivered by Dr. Ray Lyman Wilbur, President of Stanford University. Of the international phases of health work the Congress will hear from Dr. George E. Vincent, President of the Rockefeller Foundation.

Meeting at the same time in Atlantic City, the three national nursing

organizations—the American Nurses' Association, the National League of Nursing Education, and the National Organization of Public Health Nursing will hold their biennial convention; the American Child Health Association and the Conference of State and Provincial Health Authorities of North America will gather at this time for their annual meetings. The member organizations taking part are: American Child Health Association; American Heart Association; American Public Health Association; American Red Cross; American Social Hygiene Association; American Society for the Control of Cancer; Conference of State and Provincial Health Authorities of North America; National Committee for Mental Hygiene; National Committee for the Prevention of Blindness; National Organization for Public Health Nursing; National Tuberculosis Association; U. S. Children's Bureau; U. S. Public Health Service; and Women's Foundation for Health.

Exhibit facilities and special railroad rates from all parts of the country have been secured.

The 1926 meeting of the *British Association for the Advancement of Science* will be held at Oxford, August 4–11. Section H will be presided over by Dr. J. H. Fleure, Professor of Geography and Anthropology in University College, Aberystwyth.

The *XXII Congress of Americanists* will meet in Rome in the second half of September, 1926 (the circular, doubtless through error, gives '1925'). Subscriptions to the Congress have been fixed at 120 lire (Associates, 60 l.) and should be forwarded to the General Secretary of the Congress, Via Nazionale 251, Rome (5).

The *Third Pan-Pacific Science Congress* will be held in Tokyo, Japan, Oct. 27 to Nov. 9, 1926.

Dutch Anthropological Survey. The Royal Academy of Science at Amsterdam has named a Commission charged with an examination into the physical anthropological status of the Netherlands population. The personnel of the Commission is: Professor Bolk, chairman; members: Professors Barqe (Leiden), Boeke (Utrecht), van Herwerden (Utrecht), Kleiwej de Zwaan (Amsterdam), and Arziens Kappers (Amsterdam). To which have been added at the request of the Commission the General Medical Inspectors of the Army and Navy. The Commission has been divided into five sub-committees (History, Headform, Pigmentation, Stature, and Biochemical Indices) and hopes to accomplish its task in four to five years.

The Eugenics Bureau of Leningrad. The Bureau was established in 1921, through the efforts of Professors N. K. Kolcov and M. J. A. Filipčenko, under the authorization of the "Permanent Committee for the Study of Natural Agencies of Utility to Russia and the Russian Academy," and with Professor Filipčenko as Director. Its objects are: Research in Heredity; Popularization of Eugenic Knowledge; and

Direct Eugenic Service to those in need of it. The Bureau is located in Leningrad, Zverinskaja 4, Nu. 49. The first number of its "Proceedings" was published in 1922.

Anthropologie, (Prague).

The First Nordic Race Conference. From the 25th to the 28th of August representatives from Sweden, Norway, Denmark, Finland and Iceland met in Uppsala and Stockholm to discuss race problems. The majority of the papers dealt with questions relating to the Northern Countries. A Nordic Association for Anthropology (Nordisk Förening for Antropologi) was organized by Professor Lundborg, Director of the Swedish State Institute of Race Biology, who was asked to act as General Secretary of the Association.

The Second Nordic Race Conference will be held in Oslo in 1927.

Eugenics Rev., Oct., 1925, XVII, No. 3

Anthropology in Italy. A gratifying progress in physical anthropology and related branches of science is noticeable in Italy. While the old workers are passing away, a series of young and energetic men is appearing and entering upon a new era of decidedly creditable activity. Within the last two years, Professor Umberto Saffiotti has been called to the Chair of Anthropology at the University of Palermo. Drs. Rafaelo Battaglia and Ugo Rellini, habilitated as Docents in human Palethnology; and Dr. Giuseppe Genna, Aid in the Anthropological Institute of Rome, was decreted a Docent in Anthropology.

Museo "Pigorini" di Roma. The name of the Museo di Etnografia e Paletnologia in the Collegio Romano, Rome, was officially changed as above, in honor of Luigi Pigorini.

Anthropology in China. Anthropological research in China begun formally but a few years ago with the formation of the Anthropological Society of Peking (1921), is making substantial advances. The 1925 program of the XVII Biennial Joint Conference of the China Medical Missionary Association and the British Medical Association (Hongkong and China Branch) included a section of Anthropology with the following papers: Recent work in the field of prehistoric anthropology in China, by Davidson Black; New methods of measuring heights and weights, by C. McCloy; An age-height-weight study of Cantonese schoolboys, by A. E. Dome; Physical measurements of Chinese children in Shanghai and Hawaii, by V. B. Appleton; a Symposium on Racial Characters; Physical examination of students at Cheng-tu, by Kilborn; Measurements of Chinese pelvis, by L. M. Miles; Incidence of menstruation and menopause in the Chinese, by Marion Yang; Report on anthropometric data of the research committee of the C. M. M. A., by P. H. Stevenson; Relation of dentition and dental caries to age among the Chinese, by D. Black; Method of craniometry, by J. L. Shellshear; Physiological anthropometry by H. G. Earle; Occipital lobe in the brain of the Chinese by J. L. Shellshear; and Discussion on Racial Standards. The Section was under the Chairmanship of Drs. Davidson Black and J. L. Shellshear. The year has also brought a line of valuable larger pub-

lications on anthropological and archeological researcch by Black, Shirokogoroff, Andersson and Licent, not to mention a series of minor contributions (see the literature sections in this Journal).

Anthropology in Cancer Studies. Professor E. Pittard of the University of Geneva and Professor A. Niceforo of the University of Naples, have been entrusted by the Cancer Commission of the League of Nations with the study of the relations of cancer mortality with the physical characteristics of man. The racial incidence of cancer is also receiving increased attention both under the auspices of the League and outside of it.

Mental Deficiency Colony. Leeds, it is stated, is about to embark on an important colony scheme, extending the one already existing at Meanwood Park so as to accomodate 500 defectives.

Scientists Urge White Indian Reservation. Interest in the White Indians of the Darien region of Panama was revived by a resolution passed by the governing Council of the American Association for the Advancement of Science at Kansas City. Because of the great anthropological and genetic interest that attaches to these strange people, and to the Tule or San Blas nation or Indians of whom they form a part, the Council invited the attention of the United States government to the advisability of using its good offices with the government of the Republic of Panama to secure for the Indians a permanent reservation made up of their own ancestral lands, where they may be secure from commercial exploitation and from the danger of destructive infusions of low-caste mixed white and negro blood.

Appointments. Dr. Alexander Low, Lecturer on Embryology in the University of Aberdeen has been appointed by the Secretary for Scotland to the Chair of Anatomy in Succession to Prof. Robert W. Reid. Prof. Reid has held the Chair for thirty-six years having been appointed in 1889 in succession to Prof. Sir John Struthers. His successor, Dr. Alexander Low, is well known as the author of important papers on Embryology and Anthropology.

J. Anat., LX, Part I, 1925.

✠ *Luigi Pigorini.* On April 1st last, death claimed Professor Luigi Pigorini, the founder and main representative of studies relating to early man in Italy, and the founder and for nearly half a century Director of the national Museum of Ethnography and Palaeontology. Professor Pigorini was 84 years of age. The *Rivista di Antropologia*, XXV, brings his portrait with a brief obituary by the other "grand old man" of Italian anthropology, Giuseppe Sergi.

✠ The death is announced of Dr. L. Testut, Emeritus Professor of Anatomy at the University of Lyon. Professor Testut was well known to Anthropology, particularly for his description of the Chancelade skeleton.

✠ Dr. *Charles F. Sonntag*, of London, England, who in 1924 gave to science his valuable book on "The Morphology and Evolution of the Apes and Man," died last October.

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BIOLOGICAL AND SOCIAL CONSEQUENCES OF RACE-CROSSING[1]

W. E. CASTLE

Bussey Institution, Harvard University

What constitute the essential differences between human races seems to be a question difficult for anthropologists to agree upon but from a biologist's point of view those appear to be on safe ground who base racial distinctions on easily recognizable and measureable differences perpetuated by heredity irrespective of the environment. See Hooton, 1926. It is still a moot question how races originate, not merely in man, but also among the lower animals and plants. At one time natural selection was thought to be an all-sufficient explanation of the matter, but the more carefully the question is studied and the more exact and experimental in character the data which enter into its solution, the more fully do we become convinced that forms of life are rarely static, that organic change is the rule rather than the exception. Change is inevitable and is not limited to useful or adaptive variations. Natural selection undoubtedly determines the survival of decidedly useful variations, which arise for any reason, and also the extinction of those which are positively harmful, but a host of other variations fall in neither of these categories and survive among the descendants as a matter of course, quite unaffected by natural selection.

The experimental study of evolution indicates that genetic (hereditary) variations are all the time arising, and with especial frequency in such organisms as are bisexual and cross-fertilized.

In a state of nature no species can for long be separated by geographical barriers into non-interbreeding groups, without the origin of specific or racial differences between such groups. This is because new variations are fro m time to time originating in each group, and if chance

[1]This paper, prepared at the suggestion of Dr. Hrdlička, is based largely on an article published under the same title in The Journal of Heredity, Vol. 15, Sept. 1924. Thanks are due to the editor of that journal for permission to use the material here.

is an element in the origin of variations, it would be a rare event for the same variation to appear simultaneously in two geographically separated groups. Hence such groups become different irrespective of the action of natural selection. Hence the maple, sassafras, chestnut and oak trees of Asia have become specifically different from those of North America since the land connection between the two continents disappeared, although the species found in one continent will grow perfectly well in the other. Also the reindeer of Eurasia is different from the caribou of Alaska, although the two are still enough alike to interbreed and produce fertile hybrids. For a like reason the North American Indians are racially distinct from the Mongolians, their nearest of kin among human races. Time and isolation have made them different.

When isolated groups of flowering plants have become specifically distinct, they often show a tendency to remain distinct even if subsequently they are brought into the same territory. One may have become earlier or later than the other in its time of flowering, or structural or physiological differences may have arisen which make cross fertilization between the two difficult. Similarly in the higher animals (particularly among birds and mammals) a psychological element enters into the maintenance of group differences. The individual prefers to mate only in his own group and with his own kind, but circumstances may overcome racial antipathy and the overpowering impulse of sex bring about mixed unions when mates of the same race are not available. Thousands of mules are produced annually by matings between a mare and a jackass, but it often requires considerable finesse on the breeder's part to bring them about, and if asses and horses of both sexes were turned loose together on a range, it is doubtful whether a mule would be produced once in a century.

In mankind, where the race differences are less profound, so far as the physiology of reproduction is concerned, the psychological element in the maintenance of racial differences is even greater. In a population mixed in its racial composition, differences in language, religion, dress, or social customs, often keep the racially different elements distinct for centuries. The castes of India are a case in point. Since there are no biological obstacles to crossing between the most diverse human races, when such crossing does occur, it is in disregard of social conventions, race pride and race prejudice. Naturally therefore it occurs between antisocial and outcast specimens of the respective races, or else between conquerors and slaves. The social status of the children is thus bound to be low, their educational opportunities poor, their moral background bad.

There is a school of writers who insist that mixed races are inferior just because they are mixed. They cite the poor cultural attainments of the mixed races of the West Indies and of certain South American countries, maintaining that the half-breeds have all the vices of both parent races but the virtues of neither. They compare the cultural attainments of the southern U. S. with those of the northern U. S., much to the disadvantage of the former, and ascribe the difference wholly to the presence of the mulatto. They overlook or ignore a number of other factors which enter into the question, such as the kind of individuals who contracted the mixed matings and the character of the physical inheritance of their offspring, the conditions under which the children of mixed race were reared, the nature of their intellectual and moral education, the character of their economic and industrial opportunities, their ability to share in the equal protection of the law. Does the half-breed, in any community of the world in which he is numerous, have an equal chance to make a man of himself, as compared with the sons of the dominant race? I think not. Can we then fairly consider him racially inferior just because his racial attainments are less? Attainments imply opportunities as well as abilities.

Writers who appeal to race prejudice are very much in vogue. Their task is easy. We inherit from a long line of animal ancestors the group instinct, loyalty to the herd against the rest of creation. It is not difficult to persuade us that our group of races is the best group, our particular race the best race and all others inferior. There was a time when divine revelation was relied upon to establish the claim to the status of "chosen people," but now it is sufficient to write "science says." Would it not be well to inquire into the credentials of a "science," which so confidently proclaims one race superior and another inferior, and all mixtures worse than either? Is it really *science*, truth established by adequate evidence, or is it *assumption* backed up by loud voiced assertion? I share the views in this connection of Dr. Hooton as recently expressed in Science. He says (p. 76)

"A third group of writers on racial subjects, usually not professional anthropologists, associates cultural and psychological characteristics with physical types on wholly insufficient evidence. These race propagandists commonly attribute to the physical subdivision of mankind to which they imagine that they themselves belong all or most of the superior qualities of mankind, physical, mental and moral. They talk of the psychological characteristics of this or that race as if they were objective tangible properties, scientifically demonstrated. Starting

from an *a priori* assumption that physical types have psychological correlates, they attempt to refer every manifestation of the psychological qualities assumed to be the exclusive property of this or that race to the physical type in question. Great men of whatever period are claimed to be members of the favored race on the basis of their achievements and sometimes with a total disregard of physical criteria. In no case has any serious effort been made by such ethnomaniacs to isolate a pure racial type and to study either its mental qualities or its material culture. The fact that most if not all peoples are racially mixed is consistently ignored. While some of the conclusions of such writers may be correct, none of them have been scientifically established."

A commendable attempt to obtain experimental evidence on the effects of race crossing was made a few years ago by Dr. Alfred Mjoen who crossed dissimilar races of rabbits. His general conclusion was that racial crossing tends to produce physical deterioration both in rabbits and in humans. He admitted the impracticability of investigating the question critically in human populations and for that reason resorted to experiments with rabbits for critical evidence. He offers the results of two sets of experiments in one of which two different races of rabbits were crossed, in the other three. The evidences which he observes of physical deterioration are: 1. Increased size in F_1 (first hybrid generation), greater than that of either parent. This is regarded as a "weakness" because "abnormal." 2. Decreased size of some individuals in F_4 (fourth hybrid generation), which are smaller than either ancestor of pure race. Other individuals of F_4 are intermediate in size between the uncrossed ancestors. 3. Diminished fertility and increased mortality in the young in F_4 as compared with earlier generations. 4. Failure of the sexual instinct in many F_4 individuals. 5. Asymmetrical carriage of the ears, one erect, one pendant, among cross-breeds between lop-eared and albino rabbits.

The increased size of F_1 individuals is a phenomenon familiar to animal and plant breeders and frequently utilized by them. It is regularly attended by unusual vigor of growth and resistance to disease as well as by high fecundity. I have never before seen it mentioned as an evidence of physical deterioration. If it is "deterioration" to be "abnormal," all superior individuals have "deteriorated," because they are "abnormal." The races with which Dr. Mjoen started were "abnormal" as compared with the ancestral wild rabbit of Europe, all being medium to large sized (3400–4300 grams). The weights given for the F_1 individuals are 4160 and 4645 grams respectively. In F_4 weights are

given for eight individuals, ranging from 2560 to 3850 grams. The smallest of these is well above the average weight of wild rabbits and so "abnormal." Is it an evidence of "deterioration" that some of these are less "abnormal" than their immediate ancestors, or that the group is more variable than the F_1 generation?

The diminished fertility of F_4 individuals and the increased mortality of their young more probably resulted from unsanitary environment than from the mixed racial nature of the parents. The animals are reported to have been kept in this generation one or two males in a common hutch with eight females. Rabbits cannot be bred successfully in such crowded quarters and it is not surprising that only one litter of young was obtained in a period of six months. Failure of the sexual instinct and inability to produce viable young are well known consequences of an inadequate or unbalanced diet but not of race crossing in any species of animal that ever I heard of.

The asymmetrical carriage of the ears which Dr. Mjoen regards as "the most distinct outward sign of a disharmonic crossing that can well be imagined," and which he observes among three of his cross-bred rabbits, is a feature not confined to cross-breeds but of frequent occurrence among rabbits of large size, irrespective of race. Ear size in rabbits is closely correlated with body size, as I have shown elsewhere. When the ears are long, the muscles at their base are often unable to hold the ears erect, and they may lop over both to the same side, or one may lop over while the other remains upright. Ossification at the base of the ear adapts itself to this abnormal relation, as observed by Darwin (*Animals and Plants*) and the condition thus becomes permanent. The purest races of large rabbits, such as Flemish Giants and pure bred lop-eared rabbits, often show this asymmetrical ear carriage. Breeders naturally consider it a defect and in lop-eared rabbits seek to correct it in the young by mechanical means, such as manipulation with the hands to separate the connective tissue beneath the skin which joins the ears together. Books on rabbit-keeping figure leather caps to be placed over the top of the head of the young lop-eared rabbits to hold the ears apart and down. It is evident, therefore, that the asymmetrical ear carriage of Dr. Mjoen's rabbits was not due to their cross-bred state, since this same condition is found in uncrossed individuals of one, at least, of his "pure races."

From an experience of more than twenty years in the breeding of rabbits, in the course of which I have crossed nearly all known breeds, some of which differed much more in size and other characters than did

those used by Dr. Mjoen, I am satisfied that there are no breeds of domestic rabbits so distinct racially that their hybrids show the slightest diminution in fertility or vigor, as compared with the uncrossed races. Breeds of rabbits show no more racial distinctness than breeds of cattle, which are so frequently crossed in the most enlightened agricultural practice, without any indications of diminished fertility being observed.

Dr. Mjoen's conclusions rest on insufficient and uncritical observations. It would not be necessary to point this out to an experienced geneticist, but the sociologist is perhaps entitled to a biological rating of these observations.

Organic Misfits

Dr. Mjoen's argument, if I understand him rightly, assumes that all inheritance in rabbits and in men is Mendelian, and that if this is so all possible recombinations of the inherited characters will occur in F_2 and later generations. Among these recombinations, he thinks, are sure to be many organic misfits, such as small legs on large bodies. It might be supposed that in the evolution of existing races organic misfits had been eliminated by natural selection, and therefore, that surviving types are superior types which could only be made worse by intercrossing, since the frequency of organic misfits must be increased by such crossing.

The question of the production of skeletal misfits in crossing the largest with the smallest known races of rabbits, I have subjected to an extensive and intensive experimental investigation, but I have failed to observe any indication of the occurrence of misfits either in F_1 or F_2. There is a remarkable constancy in the degree of correlation between part and part within the body, quite irrespective of size. The genetic agencies which control the size of particular parts are identical with the agencies which control the size of the body as a whole. From an intimate study of the subject I am able to deny categorically Dr. Mjoen's assumption that there is inheritance, independent of general body size, of types of bone structure which regulate "the way or mode of jumping and holding—carrying—the body."

Why, it might be asked, if nature abhors race crossing, does she do so much of it? Why is it that distinct races of the same species of animal occur only where geographical isolation exists? Why does she go to such pains to ensure cross fertilization rather than self fertilization or close fertilization?

Are there such things as "harmonic" and "dishormonic" race crossings? It is assumed in Dr. Mjoen's argument that some combinations

of inherited characters are better than others, have greater survival value, and for that reason are found in existing races. As race crossing brings about recombination of inherited characters, it is to be expected on genetic principles that mixed races will be more variable than unmixed races. Is such variability a disadvantage? Yes, if all *new* combinations are inferior to those which previously existed. This Dr. Mjoen seems to assume to be true in certain cases, as in Norwegian-Lapp crosses, which he regards as "disharmonic." From his viewpoint any infusion of Lapp characters into the Norwegian complex is deterioration. Perhaps the Lapp might reasonably take a similar view of the situation. Race pride and race prejudice narrow down to just that view of all alien stocks. But to an outside observer it is conceivable that *some* inherited characters of the Lapp might be combined with other inherited characters of the Norwegian to produce meritorious racial combinations, which would be viewed with satisfaction both by the intelligent Lapp and by the intelligent Norwegian. When these combinations had gained such recognition, Dr. Mjoen would doubtless designate them "harmonic race crossings."

Now is there any way, other than trial and error, by which harmonic can be distinguished from disharmonic race crossing? I doubt it. I doubt whether there is any race of human beings whose genetic qualities are all inherently bad. I doubt whether there is any human race so "superior" that it is incapable of improvement. Dr. Mjoen is looking for some simple "blood test" chemical or serological which will show whether a proposed mating, either inter-racial or intra-racial, is "harmonic" or "disharmonic." I doubt whether he finds it. The methods of genetic analysis of inherited qualities are far in advance of chemical knowledge of the material determiners of those inherited qualities. We may reasonably expect to learn more from a study of the genetic qualities of races and individuals and their mode of inheritance than from blood tests.

Race Crossing and Social Inheritance

I doubt whether there are any race combinations which are, so far as biological qualities are concerned, inherently either harmonic or disharmonic, that is productive of better or worse genetic combinations. Both better and worse should theoretically result, if all inherited characters follow Mendel's law in transmission. A more variable population would then result, which should be on the whole more adaptable to a new or changing environment either physical or social. Is it not possible

that the racially mixed character of the populations of France, Germany, England and the United States have been one factor in their adaptability to social and economic changes?

If all inheritance of human traits were simple Mendelian inheritance, and natural selection were unlimited in its action among human populations, then unrestricted racial intercrossing might be recommended. But in the light of our present knowledge, few would recommend it. For, in the first place, much that is best in human existence is a matter of social inheritance, not of biological inheritance. Race crossing disturbs social inheritance. That is one of its worst features. And, limiting our attention to biological characters only, few of them follow the simple Mendelian law, with presence or absence of single characters, dominance or elimination. Most inherited characters are blending (the Mendelian interpretation of which is in terms of multiple factors). When parents differ in a trait, the offspring commonly possess an intermediate degree of it. This is true of stature, weight, and, I think, of general mental powers. Neither parent is devoid of stature or weight or is without mental ability. The children as a rule are intermediate between their parents as regards such traits. It is so in racial crosses, except for the complication of hybrid vigor or "heterosis" in the F_1 generation, a well known occurrence both in animal and human crosses. When two races cross which differ in stature, the children may surpass either parent in this respect, as Dr. Mjoen has observed. But the "overgrowth," as he well calls it, does not persist into later generations. It disappears, as heterosis disappears, and the population of later generations will be intermediate in character, though probably more variable than either uncrossed race. This is the outcome in numerous careful experimental investigations among animals, and may confidently be predicted as the result with similar characters in the crossing of human races.

When traits blend in human crosses, deterioration is not to be expected as a consequence, but rather an intermediate degree of the characters involved. Whether from a purely biological standpoint a particular race cross is considered desirable or undesirable will depend on whether a greater or less degree of the characters under consideration is desired.

Race-Crossing in the United States

Consider for a moment the physical (not social) consequences in the United States of a cross between African black races and European whites, an experiment which has been made on a considerable scale.

The white race has less skin pigment and more intelligence. The first difference will not be disputed, the second can be claimed at least on the basis of past racial accomplishment. As regards skin color the F_1 hybrids are intermediate; as regards intelligence it is not so easy to judge, since their environment has commonly been that of the blacks, but it will be generally admitted that they are superior in this respect to the blacks and that this has been a factor in their social advancement which has been more rapid than that of the blacks. Repeated back-crosses with whites, if permitted, might be expected to result in an approximation to the skin color and level of intelligence of the whites in a few generations. Similarly back-crosses with the blacks would naturally result in an approximation to their physical and mental standards. Matings of F_1 individuals *inter se* would continue indefinitely a race varying about intermediate standards, but varying more widely than either uncrossed race.

So far as biological considerations are concerned, there is no race problem in the United States. If social considerations were not much more powerful than biological ones, the future population of the United States would certainly be highly variable in skin color and intelligence, passing by scarcely perceptible gradations from a pure black type of the present "black belt" to a pure white type such as would result from a mixing of European races. But the social considerations *are* of much more importance than biological ones in this connection, and the racial future of the United States cannot be predicted from the latter alone.

Mixed Races From Inferior Stocks

Dr Mjoen would like to believe that the mixed race constituent of Norway's population will die out of itself, because he finds that it coexists with bad physical and social states of the population. He seeks biological support of this hope in animal experiments, but will not find it, I think, if those experiments are made critical and interpreted without bias. He should investigate also the social environment under which race crossing occurs and in which the hybrids are forced to live. In these, if I mistake not, rather than in any mysterious biological disharmonies, will be found the explanation of the alleged greater prevalence of tuberculosis, drunkenness, theft and other social evils among the mixed population. He should inquire what sort of individuals contract mixed marriages, and under what conditions. Are they the best or the worst of their respective races? Do those who contract such marriages do so from deliberate choice or only because they can find no

eligible mates among their own people? Are they individuals of force of character with passions well under control, or are they of the feebler sort, yielding readily to impulse and with unbridled passions? Is it to be expected that a cross between poor specimens of two races will result in anything but poor offspring? It is illogical to ascribe the poor quality of a mixed race to the fact that it is a mixture, provided that the original ingredients are poor. How could it well be otherwise?

Consider also the social environment in which race crossing usually occurs and in which the hybrids grow up. Crossing occurs clandestinely or, if in legalized wedlock, between individuals lost to shame. For parties to such matings are despised by both races and their children are social outcasts. Their social opportunities are decidedly limited. Is it any wonder that their social attainments are limited and that they show lack of the ordinary social inhibitions? It is not necessary to invoke biological disharmonies in order to explain the poor results of many race mixtures. Social agencies afford a sufficient explanation.

Outlook for the Mulattoes

Let us consider further, in this connection, the black-white race mixture in the United States. According to Willcox, about nine-tenths of the present population of the United States consists of whites without admixture of African blood, the other tenth consisting of blacks or black-white hybrids, known as mulattoes. If there were free intercrossing of all elements of the population, the proportion of mixed bloods should steadily increase, but this has not been the case in the past and is not likely to be in the future. At the first United States Census in 1790, according to Willcox, the negroes and mulattoes constituted about one-fifth of the total population, or twice the proportion they now represent. Instead of the increase which random matings would produce, there has been a steady decrease in the proportion of blacks and mulattoes. This has been due in part to white immigration, in part to a lower rate of increase among the blacks, but chiefly to a strong social prejudice among the whites against mixed marriages, which in many States has found expression in legislation against miscegenation, and in all States takes the effective form of a strong public sentiment against it. This same public sentiment insists on classifying as black every individual who is known to have or is suspected of having any trace of negro blood in his veins. The consequence is that marriages between whites and blacks or mulattoes are at present extremely rare and clandestine unions are uncommon.

So far as back-crossing of mulattoes with blacks is concerned, this probably does not occur with random frequency, since pure-blooded negroes on one hand and mulattoes on the other, have each a degree of group consciousness which tends to keep them apart. The mulattoes as a rule are more intelligent and have enjoyed better educational advantages so that they find more ready employment in urban life as porters, janitors, or even in clerical or professional occupations. But with urban life goes a reduced birth rate among blacks as well as whites. The prospect is that, if things go on as they now are, the mulattoes will not amalgamate either with the whites or with the blacks, but will form a separate but diminishing proportion of the total population. The blacks are holding their own in certain rural sections of the South, but elsewhere are going back numerically. No complete amalgamation of blacks with whites is to be anticipated, simply because of social impediments, though no biological barrier whatever is discoverable.

Indian-White Crosses

Another distant racial cross which has been made on a considerable scale in North America is that between European whites and North American Indians. To be sure, the number of hybrids resulting from this cross is insignificant compared with that of the mulattoes, but it is sufficient to be instructive as a biological and social experiment. The early English colonists kept clsoe to the coast and steadfastly refused to associate with the "savages," but the French in Canada were more disposed to roam the woods. Their young men explored the interior of the continent, lived with the Indians as trappers and hunters and often took Indian wives. Thus a half-breed population grew up of hardy adventurous frontiersmen. It would be difficult to find in them evidences of physical or intellectual degeneracy, other than those entailed by the introduced vices of the white race.

Within the United States, the settlement of the Mississippi Valley took place so rapidly that it amounted to a complete dispossession ofthe Indian tribes found there. These moved bodily westward to "reservations" beyond the great river. Accordingly there was little opportunity for race mixture. Nevertheless, renegade whites, who had reason to lose their identity temporarily, often joined the Indians on their reservations. As the reservation lands became valuable through the occupation of the surrounding territory by whites, the "squaw men" and their half-breed children found it an economic advantage to be members of the tribe. So when later the wild Indians were domesticated

and "given lands in severalty," the individuals of mixed race often found themselves wealthy land owners. This gave them social advantages which resulted in frequent marriage alliances with the whites. For there is no strong social prejudice against the red man such as exists against the black man, recently a slave. Consequently the pure-blooded Indians are a rapidly vanishing element of the population of the United States, and those of mixed race are being rapidly assimilated in the white population, frequently attaining positions of influence and authority. The difference in results following crossing with the black and with the red races in the United States are not referable to any biological harmonies or disharmonies existing in the respective cases but wholly to the social attitude of the whites, which is hostile in one case, indifferent in the other.

A further illustration of the surpassing importance of social over biological considerations in race-crossing is seen in the attitude of the Pacific Coast States towards Chinese and Japanese intermixture. No one questions the virility of these races or their biological fitness. Their cultural attainments are very high and antedate our own. Hybrids between these races and white races, so far as our information goes, are of high quality physically and intellectually. Yet public opinion is unalterably opposed to Oriental immigration or race mixture, not on biological grounds, but purely on social, economic, or political grounds.

So far as a biologist can see, human race problems are not biological problems any more than rabbit crosses are social problems. The rabbit breeder does not cross his selected races of rabbits unless he desires to improve upon what he has. The sociologist who is satisfied with human society as now constituted may reasonably decry race crossing. But let him do so on social grounds only. He will wait in vain, if he waits to see mixed races vanish from any biological unfitness.

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ENDOCRANIAL FORM OF GORILLA SKULLS

With Special Reference to the Existence of Dolichocephaly as a Normal Feature of Certain Primates

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INTRODUCTORY REMARKS

The recent discovery of a fossilized skull at Taungs in South Africa was an event of great importance. Professor Dart of the Witwatersrand University (Johannesburg)—our erstwhile colleague at Saint Louis and at London—described the specimen as a member of an ancient group, intermediate between living anthropoids and man, and gave it the name of Australopithecus africanus. British anatomists, prominent among them Sir Arthur Keith, Professor Elliot Smith and Professor Robinson, heralded the importance of the discovery and differed considerably as regards the true morphological significance thereof. Dart (1), in describing Australopithecus, says that "the whole cranium displays *humanoid* rather than anthropoid lineaments. It is markedly *dolichocephalic* and *leptoprosopic*." Thus the longheadedness, together with the long narrow face is regarded as a human attribute. Keith (2) lays great stress on this character and says: "Even if it be admitted that the Australopithecus is an anthropoid ape, it is a very remarkable one. It is a true longheaded or dolichocephalic anthropoid—*the first so far known*." Robinson (3), obviously impressed by the dolichocephalic character of the specimen is reported as follows: "The Taungs specimen was the distorted skull of a chimpanzee just over four years old, probably a female." Elliot Smith (4) in a lecture at University College said "Even if it be admitted, which I am not prepared to do, that some flattening of the brain case occurred after death, the absence of salient eyebrow ridges, the smallness of the jaws, and especially the reduction of the prominence of the snout, confirm the claim that, although Australopithecus is an ape nearly akin to the gorilla and chimpanzee, it does reveal a definite though slight indication of that refinement of the features which represents the early stage in the process of the assumption of distinctively human characters."[1]

With characteristic relevance, Bolk (5) immediately published a description of a strange gorilla skull from the collection in the Anatomical

[1]For latest and original study of the specimen, with new measurements and conclusions, see Hrdlička (A.), The Taungs Ape. *Am. J. Phys. Anthrop.*, 1925, VIII, Oct.–Dec. No., 379–392.

Museum of the University of Amsterdam. Out of fifty skulls, this one alone displayed marked dolichocephaly and leptoprosopy. The description of this single specimen of a longheaded anthropoid was particularly suggestive, in view of the previous controversy as to the value of dolichocephaly in classifying the Taungs skull. At this time, in company with Mr. J. Thornton Carter, I had the privilege of visiting the Natural History Museum of Lord Rothschild at Tring Park. The whole problem of the value of external and craniometric characters in determining the range of variation on the one hand, and in determining the classification of species on the other, has been discussed by Lord Rothschild (6). In particular the variations in craniometric characters were so lucidly and convincingly put forward by him that, at his instigation, facilities were made for the staff of the Institute of Anatomy to make a survey of the anthropoids in the Rothschild collection. The collection of gorilla skulls was moved to the Institute of Anatomy, and under the guidance of Professor Elliot Smith, a survey was commenced.

MATERIAL AND METHODS

The material consists of 45 gorilla skeletons from the Rothschild Collection, numbered in series from A. D. 1 to A. D. 45, of which 12 are female and 33 male; with these are considered four skulls of the Anatomical Museum of University College, of which C. A. 1, 2 and 4 are male, and C. A. 5 is female. Thus the total represents 49 skulls, 36 male and 13 female. The only skull which is not completely adult is that of a young male, A. D. 2, in which the third molars have not erupted and the occipital and sagittal crests are not well developed.

(A) CRANIAL CAPACITY

Wingate Todd (7) says that "there is no method of obtaining cranial capacity with absolute accuracy and there is no method of approximation which is not open to serious objection." His learned analyses of the various methods described by Martin, Pearson, Macdonnell and Hrdlička and the severe checking of his own methods show that the error may amount to 3%. In view of this fact the white mustard seed method (Hrdlička) was employed, filling the skull by Flower's method and emptying the seed into a 1000 ccs. cylinder by means of a large funnel the stem of which was cut short, the bore at the exit being 2 cms. Each reading was repeated five times and the average was regarded as the cranial capacity.

(B) FACIAL INDEX

The facial index is usually measured in terms of the ratio of the naso-alveolar distance to the maximum bizygomatic width. This method

was extensively employed as the "upper facial index of Kollmann." It is unsuitable for anthropoids as the nasion is not easily determined owing to the variable development of the supraorbital crest and the early union of the nasals and frontal at the fronto-nasal suture. Accordingly, the method of Bolk was pursued. The greatest breadth is measured between the right and left points at which the zygomatic arch bends itself round into the lateral orbital margin. The greatest length is measured in profile from the highest point in the mid-line of the crista supraorbitalis to the anterior margin of the premaxilla between the central incisors. The ratio of this breadth to the length, multiplied by one hundred, will be referred to as the Facial Index of Bolk. Where the Facial Index of Bolk is 100 or more, the face is classed as chamaeprosopic or broad and where the index is less than 100, the face is classed as leptoprosopic or long. The method of taking the measurements is depicted by the arrows in Fig. 1 (A) to (D), which is after Bolk (op. cit.).

(C) CEPHALIC INDEX. THE RADIOGRAPHIC METHOD

No satisfactory craniometric method for the skulls of anthropoids has yet been obtained. The only method which would permit of true comparison with man would necessitate the comparison of endocranial dimensions. This necessitates section of the skull in the mid-line, an act which destroys a band of bone from 1.5 to 2 mms. thick as a result of the spread of the teeth of the saw. All external measurements of length in the anthropoid skull are vitiated by the strongly developed crista occipitalis and, in the gorilla, the more strongly developed crista supraorbitalis. A fact which has not been so clearly recognized is the still greater error in determining the breadth of the brain case. The parietal eminences of the anthropoids are not well developed: they do not overlie the point of maximum breadth: the mastoid air sinuses in the male gorilla extend into the squama of the temporal bone superior and even anterior to the external auditory meatus and may invade the lower margin of the parietal bone by transgressing the squamo-parietal suture and so reach even to the parietal eminence. The point of maximum breadth sometimes lies as much as 4 cms. anterior to the external auditory meatus.

Keith (8) says: "The present manner of description by angles and indices is a method that leads only to the accumulation of a mass of most useless, cumbersome material. The describers seem to have lost all sight of the skull as a functional organ, with its form adapted for its two main uses, as a brain cover and a tooth carrier." Bolk (loc. cit.)

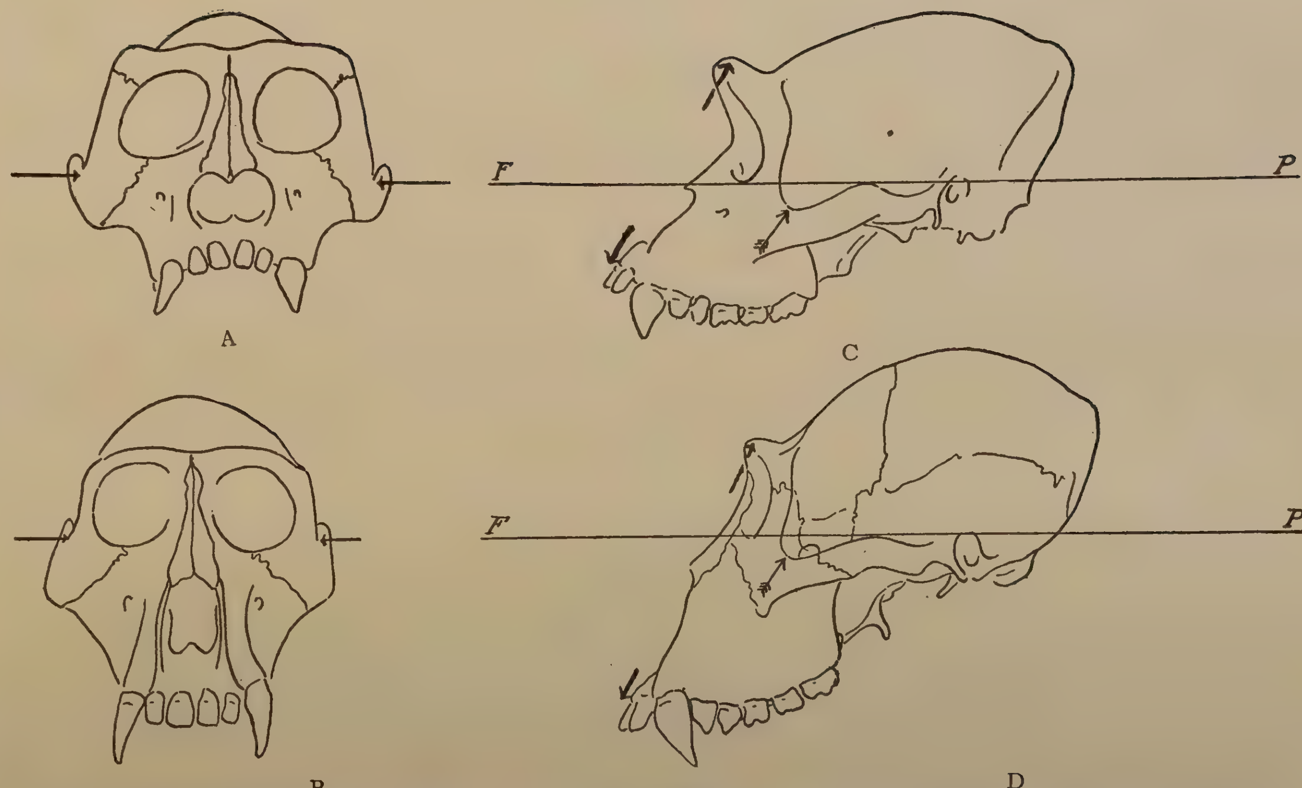

FIG. 1.—After Bolk. The arrows indicate the method of measuring the facial length and breadth in the short-faced (A) and (C) and long-faced skulls (B) and (D).

says that in studying the gorilla, "the terms dolichocephalic and brachycephalic are not truly applicable in that the index cephalicus is not taken in the same way from the full grown Gorilla as from man. Keith (9), in his determination of the average length of 10 gorilla skulls, excluded from the length the prominences due to the frontal air sinuses and the external occipital protuberance. But he measured the breadth from one parietal eminence to the other. Such a measurement of breadth is open to question, as the parietal eminence may be obscured in the adult male gorilla by the great development of the air sinuses, and the point of maximum endocranial breadth may lie as much as 4 cms. anterior to the external auditory meatus at a considerable distance from the poorly developed parietal eminence.

Bolk accordingly obtained what he calls an Index Encephalicus for the length-breadth relation of the cranial cavity. He made a sagittal section of the skull and obtained the length and breadth therefrom. The Fronton of Bolk is the point where the frontal wall and the base of the skull meet anteriorly in the middle-line. The Occipiton is the point on the occipital surface of the endocranial wall furthest from the Fronton. This is the greatest length of the cranial cavity. The greatest breadth is found by adding together the greatest depth of the cranial cavity of the right and left halves. This is a troublesome method, as in the first place a band of bone is destroyed by the act of sawing, and secondly the maximum breadth of each half has to be determined by a laborious method of trial over a considerable area by means of a depth gauge or other comparable arrangement.

Accordingly a new method was devised for the breadth-length relation of the skull. The largest gorilla skull is mounted upside down in the Frankfort plane, with cylindrical metal pointers in the right and left external auditory meatus and a third pointer supporting at its tip the left infraorbital margin. The third pointer is not quite in the same horizontal plane as the other two but lies at a distance of 2 mms. below, so as to have its sharp tip at the same level as the lower margin of the two cylindrical pointers which are thrust in to the right and left external auditory meatus. By this manoeuvre it is possible to maintain the true superior margin of the left and right external auditory meatus at the same level as the left infraorbital margin, so guaranteeing that the skull is in the Frankfurt Plane. The level of these pointers is maintained constant, but the stands supporting them can be moved to and fro on the horizontal table. The largest male skull is mounted in this manner so that the sagittal crest just clears the table.

A radiographic film is placed on the horizontal table beneath the skull; another film is mounted in a vertical plane parallel to the sagittal plane of the skull at such a distance that the distance from the Frankfurt plane to the horizontal film on the table is equal to the distance from the sagittal axis of the skull to the vertical film. Two X-ray tubes are mounted so that the upper tube is centered over the basion which is marked by a small arrowhead of lead foil, and the lateral one is centred over the external auditory meatus. The tube distance from the film in each case is constant so that the radiograms of the norma verticalis and norma lateralis are of equal magnification. Lateral and vertical radiograms of all the skulls were thus taken, so that two series of radiograms were obtained of constant and equal magnification.

Two of the skulls, C. A. 1 and C. A. 4 were now sectioned in the sagittal plane by a thin band saw. The actual maximum length and breadth was determined after the method of Bolk. Furthermore, lateral radiograms of the half skull were taken by placing the half skull with its sagittally sectioned surface in contact with the film, so that the magnification of the image was unity. Thus three standards are obtained for determining the magnification of distances in the Frankfurt plane and in the sagittal plane on the two series of radiograms. The magnification can be calculated:

(1) By actual measurement in terms of the distance of the Frankfurt plane and sagittal plane respectively from the x-ray tube and from the photographic film.
(2) By actual measurement of the two sectioned skulls.
(3) By actual measurement on the radiograms of the half skulls of C. A. 1 and C. A. 4 in which the sagittal surface is in contact with the photographic film.

All three methods showed the magnification of the radiograms to be approximately 1.1. Thus distances in the two standard planes can be reduced to actual distances by dividing such distances on the radiogram by the common magnification factor of 1.1.

It is important to stress the fact that this magnification factor can only be employed for distances which lie in the Frankfurt plane or in the sagittal plane in the radiograms of the norma verticalis and norma lateralis respectively. First of all consider the problem of the maximum breadth of the skull. In Fig. 2 the Frankfurt plane is F P and the plane of the image on the photographic film is I M. The magnification of all distances in the plane F P on the image I M is 1.1. But the actual maximum breadth of the skull lies in some position such as B H and the

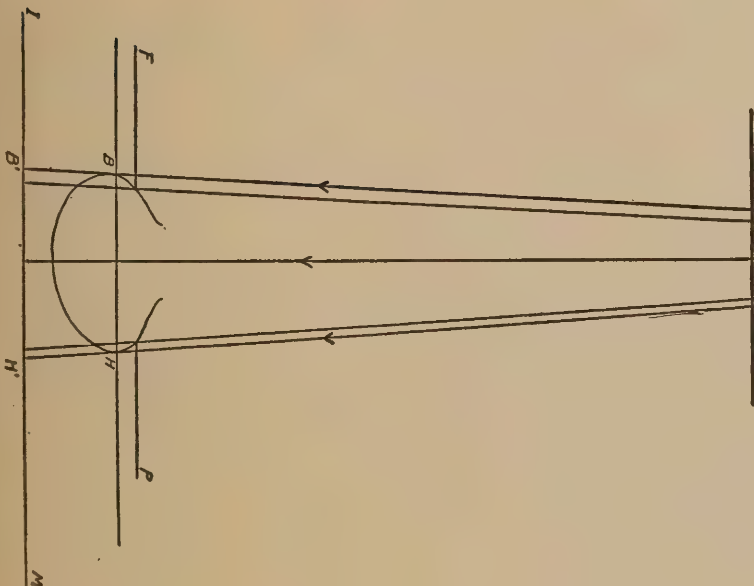

FIG. 2. Gorilla skull in position to show magnification of maximum breadth BH at B'H' in the plane of the film image IM. FP is the Frankfurt plane.

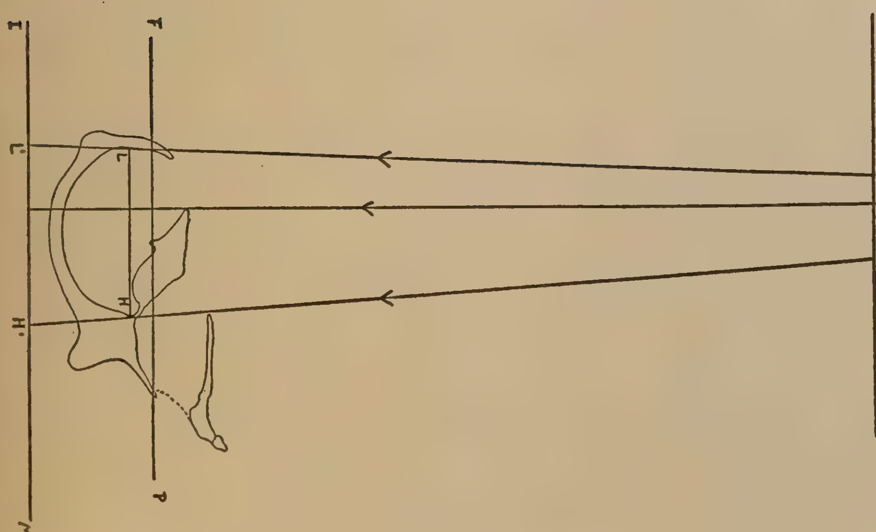

FIG. 3. Brachycephalic Gorilla skull in positon to show magnification of maximum length LH at L'H' in the plane of the film image IM. FP is the Frankfurt plane.

magnification of this line on the plane of the image I M will be less than 1.1, in proportion as B H recedes from F P and approaches I M. The actual apparent maximum endocranial breadth on the radiogram was measured and divided by 1.1. This gives a reading for the actual breadth which is too small, as the magnification of B H on an average is in the neighbourhood of 1.07 to 1.08. The apparent maximum breadth was measured on the series of radiograms of the norma verticalis and in each case this dimension was divided by 1.1, so giving a series of values for the breadth of the skull which were uniformly high.

As regards the maximum length of the skull, in addition to the factor considered above for breadth, there is another factor due to the obliquity between the actual line of maximum length and the Frankfurt plane. In Fig. 3, F P is the Frankfurt plane, I M is the plane of the image and L H is the actual maximum length in the sagittal plane. The magnification of all distances in the plane F P on the image I M is 1.1. The magnification of L H in the plane I M is less than 1.1, according as L H recedes from F P and ranges between 1.08 and 1.09. Moreover the projection of L H on the plane I M is decreased proportionally to the angle of obliquity of L H to F P. In the case of a longheaded skull (Fig. 4) this obliquity is usually less than 10° and in the case of a broad headed skull the obliquity is almost nil. The obliquity of L H to F P and to I M will thus cause the length to be shortened on the image by a factor ranging from cosine 10° to cosine 0° i.e. from 0.98 to 1.00. Accordingly, in view of the relative insignificance of this small obliquity, the apparent maximum length as measured on the series of radiograms of the norma verticalis has been divided in each case by the standard factor of magnification 1.1, in order to obtain the endocranial length of the skulls.

Both length and breadth have thus been calculated by dividing the maximum length and breadth on the series of radiograms of the norma verticalis by 1.1 and the index is called the "*Radiographic Encephalic Index.*" The errors of the method due to the position of the lines of maximum length and breadth have been shown to be within 2%. It is hoped by further development of this technique to obtain an absolute measurement for the actual maximum endocranial length and breadth.

(D) EXOCRANIAL CEPHALIC INDEX

For the purposes of comparison a series of measurements were made on the external aspect of the skulls, the length being measured ad maximum from the external occipital protuberance to the supra-orbital crest, and the width from the upper margin of one external

auditory meatus to that of the other. This is called the "Exocranial Cephalic Index." Such an index will show a very wide range because of the marked variation in the development of the crests and air sinuses of the skull.

GORILLA SKULLS OF ROTHSCHILD COLLECTION

No.	Sex	Cranial capacity in ccs.	Facial index of Bolk	"Radiographic" Encephalic index, endocranial index	"Exocranial" cephalic index	Locality
C. A. 1	♂	560	110.9	84.7	87.2	
2		652	129.2	80.5	70.9	
4		510	111.0	84.7	84.7	
A. D. 2		490	100.7	85.8	78.8	
A. D. 14		550	113.7	*74.4*	*67.6*	Gaboon
15		560	*97.5*	78.2	*74.6*	
16		547	111.6	76.9	78.5	
17		460	111.3	80.3	*73.9*	
18		500	100.0	80.3	*72.6*	Gaboon
19		495	111.8	80.8	*66.5*	French Congo
20		460	112.5	76.8	77.3	
21		470	109.1	77.2	77.5	French Congo
22		?	113.6	75.2	78.6	Cameroons
23		490	113.5	*73.2*	*70.1*	Gaboon
24		?	120.8	76.6	78.0	S. Cameroons
25		510	108.9	*72.1*	*72.9*	
26		?	110.3	77.2	83.0	S. Cameroons
27		?	113.6	81.1	76.4	
28		?	101.4	77.2	75.1	Nguni River
29		?	110.4	79.7	*70.4*	
30		?	*97.7*	79.2	*65.6*	
31		550	*96.3*	78.7	*66.7*	Nguni River
32		?	114.4	*74.0*	*69.3*	Cameroons
33		580	113.6	*74.4*	78.2	
34		440	111.1	76.6	*68.4*	Gaboon
35		465	108.1	*74.2*	77.8	French Congo
36		480	104.1	79.5	*68.6*	
37		?	106.1	80.1	84.7	Cameroons
38		520	*97.9*	76.0	75.6	Cameroons
39		?	*92.9*	76.0	*67.0*	Cameroons
40		560	125.3	*72.7*	*72.4*	S. Cameroons
41		455	105.0	82.5	*64.9*	Gaboon
42		?	*97.5*	81.4	76.0	Cameroons
43		?	*96.8*	77.2	76.9	Bonila R.
44		480	110.5	*74.2*	*60.4*	Gaboon
45		?	?	75.0		Nguni River
C. A. 5	♀	475	108.7	82.6	82.9	
A. D. 1		460	*96.2*	85.2	79.4	Gaboon
3		415	110.6	80.0	77.1	
4		450	114.0	78.3	75.5	Cameroons
5		425	110.4	79.1	75.5	Gaboon
6		430	110.9	84.2	76.4	
7		?	106.5	84.8	77.1	Bonila R.
8		420	102.4	86.8	75.1	French Congo
9		450	106.0	82.8	79.5	Gaboon
10		442	*98.5*	84.9	76.8	Gaboon
11		457	110.9	82.8	76.5	
12		?	107.5	79.7	?	Cameroons
13		440	105.8	80.7	81.0	

(A) Cranial Capacity

Collection	Total No. of skulls	Type	Average	Max.	Min.
Rothschild	34	M. & F.	490ccs.	652ccs.	415ccs.
(H. A. H.)	23	M.	513	652	440
	11	F.	442	475	415
	29	Chamaeprosopic M. & F.	487	652	415
	5	Leptoprosopic M. & F.	506	560	442
	27	Brachycephalic (Radio. endocranial) M. & F.	482	652	415
	7	Dolichocephalic (Radio. endocranial) M.	519	580	465
Bolk(5)	39	M. & F.	528	655	390
	27	M.	550	655	450
	12	F.	478	595	390
Martin(10)	?	M.	508	585	420
	?	F.	435	550	370
Hrdlička(11)	?	M.	?	623	420
	?	F.	?	580	370
Keith(12)	13	M.	497	573	425
	7	F.	450	496	393

Notes:—The greater the number of gorillas examined, the greater does the average cranial capacity tend to become. Whereas Keith gives the average capacity as 470 ccs. with a maximum of 620 ccs. Hagedoorn (13) says that this average is far too small as it is already surpassed by that of certain female skulls. The Rothschild skulls give an average of 490 ccs. for both sexes; 512 ccs. for the male and 442 ccs. for the female. This is not as large as the average given by Bolk i.e. 528 ccs. for both sexes, 550 ccs. for males and 478 ccs. for females. Hrdlička discusses the ratio of the female cranial capacity to the male capacity as an index in terms of 100, and quotes Oppenheim (14) to the effect that the value is 85. Bolk's figures give a value of 86.9, Keith's 90.5, and the present collection 86.3, a value which is very close to that of Bolk.

The average cranial capacity of the nine leptoprosopic skulls is 506, with a range from 442 to 560 ccs. The average of the eight dolichocephalic (radiographically) skulls is 519, ranging from 465 to 580 ccs. Bolk's single specimen falls within these limits with a capacity of 550 ccs.

(B). Facial Index of Bolk.

Collection	Total No. of skulls	Type	Average	Max.	Min.
Rothschild (H. A. H.)	48	M. & F.	107.9	129.2	92.9
	35	M.	108.3	129.2	92.99
	13	F.	106.8	114.0	96.2
	39	Chamaepros. M. & F.	110.4	129.2	100.0
	9	Leptopros. M. & F.	96.8	98.5	92.9
	28	Chamaepros M.	111.1	129.2	100.0
	7	Leptopros. M.	96.7	97.9	92.9
	11	Chamaepros. F.	108.5	114.0	102.4
	2	Leptopros. F.	97.3	98.5	96.2
Bolk	49	Chamaepros. M. & F.	111.5	122.6	103.4
	1	Leptopros. M.	89.5		

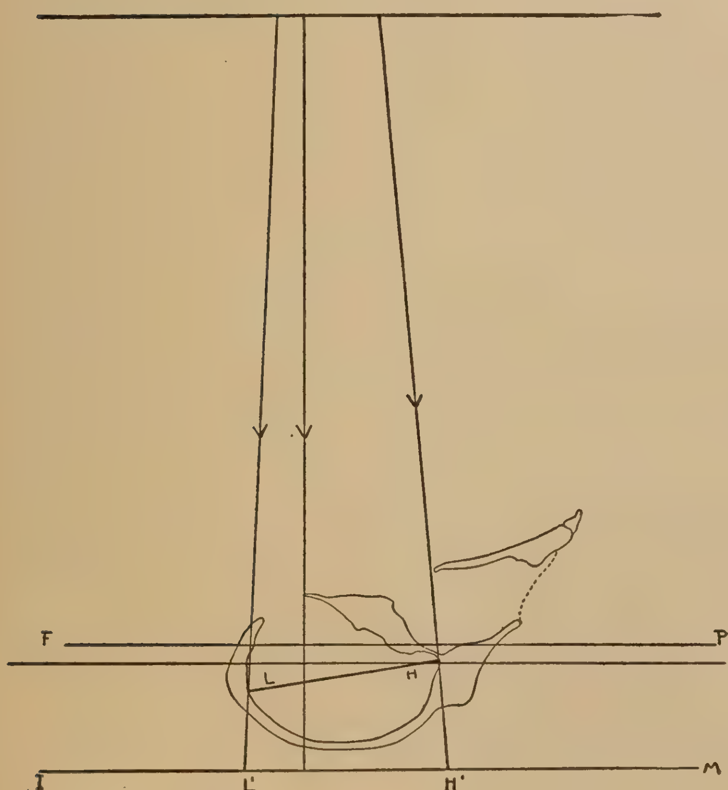

Fig. 4. Dolichocephalic gorilla skull in position to show magnification of maximum length LH at L^1H^1 in the plane of the film image IM. The maximum length LH makes an angle with the FP and IM.

Notes:—Leptoprosopy characterizes nine of the gorillas examined. The average value of the facial index in the nine leptoprosopic skulls is 96.8, ranging from 98.5 to 92.9. Not one of the skulls was so markedly leptoprosopic as Bolk's sole specimen which had a value of 89.5. Of the chamaeprosopic skulls 15 range from 100 to 109.9, 21 range from 110 to 119.9 and three have values above 120. The most markedly chamaeprosopic skull, (C. A. 2) is also that male skull which has the largest cranial capacity, with marked development of the crests and air sinuses. Two of the female skulls are leptoprosopic.

(C). Radiographic Endocranial Index, or Encephalic Index.

Collection	Total No. of skulls	Type	Average	Max.	Min.
Rothschild (H. A. H.)	49	M. & F.	79.1	86.8	72.1
	36	M.	77.9	85.8	72.1
	13	F.	82.4	86.8	78.3
	41	Brachyceph.	80.2	86.8	75.0
	8	Dolichoceph.	73.6	74.4	72.1
	40	Chamaepros.	79.0	86.8	72.1
	9	Leptopros.	79.6	85.2	76.0
Bolk	10	Brachyceph.	?	85.9	80.6
Keith	?	Brachyceph.	80.0	?	?
Keith(2)	1	Taungs Skull	71.0		
Hrdlička(16)	1	Taungs Skull	74.0		

Discussion:—The radiographic method of estimating the endocranial index shows that eight of the skulls are dolichocephalic. On the average, the male skulls display a much wider range of variation than the female. The female skulls range from 78.3 to 86.8 with an average of 82.4, whereas the male range from 72.1 to 85.8 with an average of 77.9. Thus the dolichocephalic character is more marked in the male, in terms of endocranial measurement. All eight dolichocephalic skulls were male. The thirteen female skulls were consistently brachycephalic. This brachycephalic character of the female gorilla skull is comparable to what is found in the female human skull. Yet, two of the female skulls are leptoprosopic.

The average endocranial index of the chamaeprosopic and leptoprosopic groups are very close together, 79 and 79.6 respectively. Although Bolk's specimen was both leptoprosopic and dolichocephalic, it should be noted that there is no close correlation between the leptoprosopic and dolichocephalic characters in members of the Rothschild series. Not one of the nine leptoprosopic skulls is dolichocephalic as they have endocranial indices which range from 76 to 85.2, with an average of 79.6. Conversely, not one of the eight dolichocephalic skulls is leptoprosopic, the eight dolichocephalic skulls having facial indices which range from 108.1 to 125.3 with an average of 113.5. Hrdlička

(15), in a comparison of the facial with the cephalic index in a series of orang skulls, pointed out the lack of correspondence between these two indices, and suggested that "the facial growth is apparently controlled, unlike in man, much more by the development of the teeth and facial muscles than by that of the cranial vault."

The absence of close correspondence between the facial indices and endocranial indices in the gorilla demonstrates that the development of the skull and the development of the face cannot be too closely related in terms of "brain cover" and "tooth carrier."

The preliminary estimates of the cephalic index of Australopithecus have varied from 71 by Keith (2) to 74 by Hrdlička (16). These figures lie between the limits of the dolichocephalic gorillas of the Rothschild Collection and between the limits of dolichocephalic man. Too much importance should not be attached to the cephalic index in interpreting a given anthropoid or human specimen. Bunak (17), in a recent study of the lambdoid and sagittal crests of anthropoids has shown that there is a close, but not a full correspondence between the extent of the temporal muscles, the size of the canines and the development of the lower jaw. There is, apart from these factors, what he calls a "crest factor" which is a systemic character of certain species and sub-species of Primates. It is this same "crest factor" which Lord Rothschild has employed in the separation of the species and sub-species of gorilla. Similarly with regard to supra-orbital crests, the facts have been clearly stated by Elliot Smith (18): "The development of the eye-brow ridges is not of much importance as an index of race. It is neither an exclusively primitive character nor a distinction of higher race. It is found developed in Pithecanthropus, Rhodesian Man, Neanderthal Man, and in the Australian and Alpine Races, whereas a defective development of the ridge is characteristic of Eoanthropus, the Negro, the Mongol and the Mediterranean Races, while the Nordic Race occupies a position between the two."

As for the skull crests so for endocranial skull form; there is not only a "*muscle*" factor, a "*dentition*" factor a "*face*" factor and a "*brain*" factor, but there is also a "*skull*" factor which is at present too complex to be analysed in terms of race alone.

In Fig (5) are shown the radiograms of the norma verticalis of seven of the gorilla skulls selected at random on the basis of the differences in skull form pointed out by Lord Rothschild. The range of the endocranial or encephalic index obtained by the radiographic method is from 72.1 to 86.8, the upper row being brachycephalic; and the lower row dolichocephalic.

FIG. 5. Radiograms of the norma verticalis of seven gorilla skulls selected at random by sight to show differences in skull form described by Lord Rothschild. The endocranial cephalic indices are:—

Top Row. A. D. 40 = 72.7. A. D. 14 = 74.4. A. D. 25 = 72.1.
Bottom Row. A. D. 2 = 80.5 A. D. 1 = 85.2. A. D. 8 = 86.8. A. D. 26 = 76.6.

(D). Exocranial Cephalic Index.

Collection	Total No. of skulls	Type	Average	Max.	Min.
Rothschild (H. A. H.)	48	M. & F.	74.9	87.2	60.4
	36	M.	73.9	87.2	60.4
	12	F.	77.7	82.9	75.1
	30	Brachyceph. (exocranial)	78.3	87.2	60.4
	18	Dolichoceph. (exocranial)	69.2	74.6	60.4

The wide variation in the exocranial cephalic index is due to the great variation in the development of the crests and air sinuses in the male skull. Here again the female shows but a small degree of variation, with a range from 75.1 to 82.9 and an average of 77.7 whereas the male ranges from 60.4 to 87.2 with an average of 74.9.

SUMMARY

1. A method is devised for rapidly obtaining by radiographic means a breadth-length ratio for the endocranial aspect of the intact skull.

2. Dolichocephaly is demonstrated in eight gorilla skulls in a series of 49 and leptoprosopy is also demonstrated in nine of the skulls. In no case was a given skull both leptoprosopic and dolichocephalic, so that the correlation between skull form and face form is not very marked within the series.

3. Dolichocephaly, per se, cannot be employed as a character of any importance in deciding whether a given fossil skull possesses humanoid characters.

4. The range of cephalic index in this series is comparable to the range shown by man, from 72 to 87, both in the New World and the Old.

CONCLUDING REMARKS

Further attempts are being made to devise a speedy method of obtaining the maximum endocranial length and breadth of the skulls of anthropoids by means of the use of the fluoroscopic screen and internal callipers. Our thanks are due to Lord Rothschild for placing this unique collection of gorilla skulls at our disposal and it is proposed to study the question of geographical distribution of species and sub-species when an opportunity is found to examine the records concerning location of the specimens in detail. Mr. Melville and Mr. Farey, technical assistants at University College, have devoted much time and thought to the perfecting of the method. My colleagues at Washington University have also been most ready to assist.

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THE RHODESIAN MAN[1]

ALEŠ HRDLIČKA

On June seventeenth, 1921, a very remarkable human skull was discovered in the Broken Hill Mine, Northern Rhodesia. It was the skull of a man whose features were in many ways so primitive that nothing quite like it has been seen before; and coming from a part of the world which hitherto has given nothing similar and in which nothing of that nature was ever suspected, it aroused much scientific attention.

Fortunately the specimen was saved with but a minor damage, and later in the same year was brought by the manager of the mine to the British Museum of Natural History where, safely preserved, it constitutes one of the scientific treasures of that Institution.

The detailed circumstances of the find were, however, not as fully and definitely established from the start as would have been desirable. The specimen was found and taken out by a miner, there was no scientific man on the spot, and the wonder is that so much was saved and done. The whole occurrence is to the lasting credit of all concerned.

The lack of precise information on certain important points was soon felt by the students of the subject; and it now seems that even what was known at first suffered some subsequent confusion.

The sparse data about the Rhodesian find left a desire for more details about the position of the skull, about its surroundings, about the cave itself and its fillings, about the nature of the animal bones in the cave, about the general region in which the "broken hill" with its cave existed, and about possible other remains, as well as the native types of the territory. The skull was so remarkable that every view of it and every further word published upon it served only to intensify the feeling of need for more complete answers to the above questions. It was this motive, together with the recent discovery of the skull of a highly interesting anthropoid ape near Taungs, Bechuanaland, that induced the writer to extend his late journey to South Africa.

The success of his visit to Northern Rhodesia was due largely to the aid of Professor Dart of Johannesburg, and to the fine men in charge of the "Rhodesia Broken Hill Development Company." Of the latter particular thanks are due to Messrs. Ross K. Macartney, the General Manager; George W. Rudyerd, Assistant General Manager; W. E. Barron, former Captain of the Mine; and G. Chad Norris, Engineer.

[1]This report represents a part of the results of the author's Smithsonian-Buffalo Society of Natural Sciences expedition, 1925.

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But there were many other helping hands including Dr. Wallace, Messrs. Jolly, Zwigelaar, Hayward and still others, whose assistance is hereby gratefully acknowledged. The efficient and high-minded officials of the mine deserve the thanks of the whole scientific world, for it was due to them only that the Rhodesian skull was preserved and brought in safety to the British Museum. These gentlemen extended to the writer every facility. They would doubtless do this to any other qualified student, and they will henceforth watch keenly for all further discoveries on the site and in the vicinity.

Upon arrival at Broken Hill the writer was rather astonished to find the whole region for many miles in every direction to be a great, level, loosely forested plateau, without any hills with one slight exception. This exception is a small "kopje" situated near the railway tracks as one nears the Broken Hill mine and settlement. This little hill, only about 90 feet high, is said to resemble closely the former "broken" hill which gave us the Rhodesian man and which has now, through mining, been removed.[2]

The plateau of the town of Broken Hill is 3874 feet above sea level. Up to the time of the commencement of mining operations it was a part of a vast, featureless, more or less openly forested region. But the minerals in the two "kopjes"—lead and zinc—may have been known to the natives in earlier times. At all events, in digging ditches and in other surface excavations about the mines and in the town, there are being found, buried up to 8 feet in depth from the present surface, old primitive native smelters, with here and there some negro pottery, indicating probably former burials. Mr. J. H. Hayward in charge of the surface works, has found such an old primitive, probably negro smelter under the roots of a big tree, and he led the writer to a ditch where from 6 to 8 feet below the surface were seen *in situ* large fragments of thick black native pottery. There evidently existed here at one time a native settlement the men of which worked some metal. The smelters may, however, have been used for iron or other metal than those found in the two small local hills.

The "broken" kopje consisted of hard dolomitic limestone impregnated with lead, zinc salts and vanadium. It was originally full of crevices and holes, and, as shown in the course of mining also at least two large caves leading deep into the interior.

[2]In one of the accounts to be quoted later mention is made of several such small hills, but only one and the remains of the one that gave the skull were seen by the writer.

The cave of special interest became known as the bone cave. This cave in the course of time had become filled with sand, soil, bones of animals and detritus of various kinds, which in turn were impregnated by seepage carrying in solution mineral salts and lime. The salts formed incrustations on the walls, here and there new ore deposits and in general consolidated most of the contents, bones included, into a "paying ore."

The kopje that yielded the "Rhodesian skull" was situated approximately northwest to west of the present railroad station, and was about 50 feet high by 250 feet in its longer diameter. This entire elevation has now disappeared and where there was a hill there is now a deep hole, in and about which mining operations are still energetically proceeding.

Mining by white men is said to have begun at "Broken Hill" in 1895. Information about these times is hazy. The tradition is that the "broken" hill before mining looked much like the kopje now remaining; that its weathered and irregular surface was, as already said, honeycombed with holes and crevices; but that none of the openings apparently led to the cave that eventually proved to be the great bone, débris and ore-filled crevice which in 1921 gave the Rhodesian man.

The main part of the bone cave appears to have been entered by the miners accidentally in the course of their operations, was partly excavated and found to contain large quantities of more or less mineralized animal bones, with some stone implements. Of this occurrence there are reliable records.[3] The initial notes on the subject are of such value, and at least one of the reports is so difficult to find, that the relevant parts are reproduced in full at the end of this paper.

So much for the earlier information about the Broken Hill cave, and nothing further appears to have been said in print about it until the latter part of 1921, when the Bulawayo and other South African papers brought news about the discovery of the "Rhodesian skull."

These earlier reports of which the writer saw copies at the office of the Broken Hill Development Company, are of the usual newspaper style and outside of signalling the discovery give little of value. The first more detailed notices of the find appeared on November 8, 9, 10 and 11, 1921 in the London "Times." Shortly after that, on November 17, the first brief scientific report of the find was published in "Nature" by Professor Smith-Woodward; and on November 19 a comprehensive and gorgeously illustrated report by W. E. Harris,[4] as well as a descrip-

[3] Mennell (F. P.) and E. C. Chubb—On an African Occurrence of Fossil Mammalia associated with Stone Implements. *The Geological Mag.*, n. s., Decade V, IV, Jan.–Dec., 1907, 444 *et seq.* See Appendix I.

[4] See Appendix II.

tion of the skull itself by Sir Arthur Keith, was brought by the "Illustrated London News," with the addition of an ingenious restoration of the race of men represented by the specimen.

Four years have elapsed since then. In their course at least eight further brief scientific contributions on the subject of the "Rhodesian Man" have seen light. But a thorough, final study of the subject and the specimen is still wanting. It was expected from Professor Smith-Woodward in whose care the skull and other objects from the cave were placed. There is, however, a fear now, with Professor Smith-Woodward's retirement on pension from the British Museum, that such a report may be remote. And the skull, with the type and age of the human form to which it belonged, remains still largely a puzzle. Moreover, errors of a serious nature have crept into the accounts of the circumstances of the discovery and have already materially affected important conclusions.

What one learns definitely from the early notices of Broken Hill, by one of the chief officials of the mine (Engineer Franklin White), is that about 1907 the bone cave was found accidentally in tunnelling operations; that it was not known to have any outward opening; that it was nearly filled with large quantities—many tons—of more or less mineralized bones, clay, débris and ore; and that with the bones were fairly numerous quartz and chert implements, resembling in general those of Bushmen and perhaps other African natives of protohistoric and prehistoric times.

Some of the implements and bones were saved through the instrumentality of Mr. White and donated to the Bulawayo Museum. They were later studied by Mennell and Chubb. Still later the bones came to the British Museum and were examined by Andrews. They were diagnosed, with one probable exception, as belonging to recent forms of Rhodesian mammals. There were no human bones in the collection. The archeological objects were noted but the find was not followed up.

Then came the accidental great discovery of 1921. Again there was no scientific expert on the spot and none came after. The details were not noted in writing. The news circulated in the South African papers, but there was no authoritative account, the reports differed from the first and included inaccuracies.

Five months after the discovery the skull, and a number of human as well as other bones, were brought by Mr. Macartney, the Manager of the Mine, to England and were generously donated by the Company to the British Museum (Natural History). No written statement accom-

panied the donation. But from the oral account of Mr. Macartney, and above all from the good illustrated article by William E. Harris, an official of the mine, in "The Illustrated London News," November 19, 1921, there became established a notion of the details of the find which was gradually adopted by all writers on the skull and which is responsible for serious uncertainties. Above all it became an accepted idea that several human bones brought to England with the skull were found with the cranium and belong to the same body or same people, and from the characteristics of these bones deductions were made as to the morphological and even chronological status of the Rhodesian man. Some measurements of the skull and bones were published, also a few observations and thoughts on the endocranial cast which represents the brain; a tacit expectation was reached that a complete report on the case was being prepared by Professor Smith-Woodward; and active interest was gradually transferred to new discoveries.

These were the data and that was the state of affairs when the chance to visit the Broken Hill locality came to the writer during the past summer.

With the utmost cooperation of the officials of the mine, and in fact, of every one approached, the first task was to learn on the spot as much as possible of the history of the 1921 discovery. This unexpectedly proved no easy matter, due to a scarcity of the old employés, but especially to the uncertainties of memory of those who had been present at that time. The following nevertheless appeared to be the concensus of the recollections:

Before mining began in this craggy "broken" kopje there was nothing to indicate the presence of any human habitations about the hill. If there was anything it was not conspicuous and escaped notice.

Mining was carried on from a side, but due to the conditions of the mineral deposits work was later commenced also from the top proceeding downwards. During the earlier operations from the side, a good sized cave or fissure was reached and found to contain dirt, ores and numerous bones. The bones were those of animals; if any others were present they were not noticed. They were mostly so mineralized that they were in the main smelted with the rest of the ore, and after the first impressions received little further attention.

When the excavations from the top reached in the center to approximately 90 feet below the surface of the ground surrounding the kopje, a large inclined plane was opened to the central funnel from near the side at which the original work began. At some distance this plane once

more encountered the large bone crevice that had been discovered before. The crevice passed here obliquely across part of the incline, and as in the earlier seen portion was filled with detritus, bones of bats or rodents, ore and more or less mineralized bones of larger animals. The extent and contents of this cave or crevice were only learned gradually in the course of the prolonged work of mining.

After the inclined plane reached the bottom of the central excavation, some of the workmen were directed to turn back and work on the ore and stone exposed by the plane; and it was in these parts, not long after, at a level of approximately 60 feet below the surface, that a Swiss miner, Mr. T. Zwigelaar, working with his black "boy" in some softer fillings, was confronted after a stroke of the boy's pick with the Rhodesian skull.

It is primarily to the lasting credit of this miner that the specimen was carefully taken out, saved, brought to the attention of his superiors, and reached the right hands. These hands, at the advice of the Manager of the mine were those of the Company physician, Dr. A. F. Wallace, and he safeguarded the specimen for three weeks in his office. It was then taken in charge by the Manager, Mr. Macartney, to be later in the year personally transported by Mr. Macartney to the British Museum. There was much more to all this than here expressed and some of the details were stated differently by different persons, but the above appear to be the simple essentials.

FURTHER EVIDENCE

After learning the generalities and being shown over the mine by Mr. Rudyerd, the writer endeavored to reach personally every man concerned with the find or on the spot at that time, who might still be found at Broken Hill or reached through the mails, in order to obtain from each one independently as detailed and circumstantial information about the discovery as it might still be possible to get. As only four years have elapsed since the time that the find was made it was hoped that a number of the men who were concerned with it would still be found on the spot and that their memories of the find would still be quite clear and reliable.

As good fortune would have it, before the writer's departure from Broken Hill he was able to locate and interview five of the men concerned from the beginning in the discovery, including Mr. Zwigelaar who actually found the skull; and a sixth one was reached later by a letter. Each of these men was most willing to tell all he knew; but their memories regrettably were no longer clear as to the particulars. However, what was obtained is not without importance.

The most noteworthy information is that of the discoverer of the specimen, Mr. Zwigelaar. He was found to be a serious middle-aged man, not highly educated but of good common sense, and he tried hard to give the main facts of the find as he remembered them. The gist of his statements, repeated and reasserted, follows:

"It was about 10 a. m. one day. We were working back from the incline at its lower part. I had a colored boy (young man) with me and we were 'hand picking' in a pocket where there was much lead ore. The digging was not hard, not like stone, more loose. After one of the strokes of the pick some of the stuff fell off, and there was the skull looking at me. It was very strange and with some of the matter adhering to it looked so unlike an ordinary human skull that I thought it was a big gorilla. I took it out carefully, showed it to the officials of the mine and others, and later that day brought it in to Mr. Macartney who in turn sent it to Dr. Wallace. Soon after the find was made Mr. Macartney (I believe) took a photograph of me holding the skull against the place where it came from (Fig. 1),[5] and other photographs were taken also.

The skull was at some depth under the pure lead ore and, as far as I can recall, about 10 feet below what seemed to be the floor of the bone cave further away. Where we were then I could see no connection between the material about the skull or the pocket it was in and the bone cave, though it may have been [and later was shown] to be the same old crevice. They were separated by the lead ore and the stuff in which the skull lay. That ore was very rich; it was not hard though necessitating the use of a pick. There was much of it further in and above.

There were no other bones close to or near the skull, and no other objects that aroused attention. But a little later and not far below the skull we came on a sort of a bundle which looked like a flattened roll of hide standing nearly upright; the hide was thick and was of ore; it showed no remains of a real hide but looked somewhat like it. Pieces of it were removed and shown about, the rest was smelted. There was nothing within the 'roll'—no bones nor any other object.

The skull was surrounded by softer stuff. There was something like bat bones. There were hard and soft spots in the digging. Next day we looked for the lower jaw but nothing was found.

Some time afterwards, but on the same day, we found outside of where the bundle was and to one side of it, about three feet away as near as I can remember, the leg bone of a man. There were no other

[5]This precious and unique photo was loaned by Mr. Zwigelaar to the writer and is here reproduced.

bones. Later and lower was found a skull said to be that of a lion; but that was not found by me.

The skull was taken first to the Manager's office and from there to the Doctor's. That's all I know."

So much for Mr. Zwigelaar. On repeated questioning his account remained the same. He was positive the skull was alone, without the lower jaw and without any other bones in association. He also was positive that there was no covering of the skull and that the "roll" lay lower and not in connection with the specimen. Directly behind the skull there were some bat bones.

Fig. 1.

The next most important person still present at Broken Hill was the Mining Captain at the time of the discovery of the skull, Mr. W. E. Barron. Mr. Barron was found at the site of the new dam and power tunnel about 20 miles from Broken Hill and was brought back to the mine. Unfortunately his recollections of the details of the discovery were already hazy. However he produced an old note book in which he had written, shortly after the find was made (a day or two later) the following valuable notes:

"Old Bone Cave: Skull found at side of incline about 60 feet level, by Zwigelaar, 17–6–21. A mass of small bones (probably bat bones) all around it.

In afternoon of same day big portions of animal skull with teeth in good condition (apparently lion) found in same place (speaking generally) by Angelo."

All other information regarding this lion's skull is to the effect that it was found at some distance away from the skull, possibly as much as 8 or 10 feet, and at a considerably lower level. It was impossible to ascertain conclusively what had become of this specimen. There is a somewhat mineralized lion's skull, proceeding doubtless from some part of the bone cave, in Mr. Macartney's office and it may be the specimen in question; or it may have been forwarded to the British Museum.

Mr. Barron assured the writer also that in the same digging there was found an artificially made quartz ball about 3 or a little over 3 inches in diameter (size of a fist). Zwigelaar upon re-interrogation in the presence of Mr. Barron was sure that there were no bones whatever, human or animal, near the human skull except the bat bones; neither could he remember anything about the stone ball. A stone ball answering to the description was later brought to the writer with a statement that it came from somewhere in the end part of the crevice and was taken by him with other objects to the Museum at South Kensington. However, two similar balls from the cave had also been taken to the Museum with the skull in 1921 (see later).

Mr. Barron's name in the English records of the find is given as "Barren," and as in the same records he is reported as the discoverer of the skull, the writer asked him for a written statement on both points. The result was the following letter which settles both questions:

Mulungushi, R. B. H. D. Co. Ltd.
Broken Hill, N. Rhodesia.
12th Dec. 1925.

Dear Mr. Hrdlička,

I was very glad to get your letter. I have come across the correspondence of Dec. 1921, which I mentioned to you, and, as it has bearing on the whole matter connected with the skull I am enclosing it all for your perusal. The copy of my letter to Mr. Moffat I have just made from a pencilling I had with the others.

It was Zwigelaar and his boy who saw the skull *in situ* and extracted it, and Zwigelaar brought it to my office. I was Mine Captain in charge of mining operations.

The collar bone and the case referred to in my letter to Mr. Moffat were certainly in the close vicinity of the skull, and we attributed them to the same skeleton at the time, the casting being taken for the fossilised remains of the skin he was wearing. . . .

With kindest regards,

Yours sincerely,
(Sgd.) W. E. Barron.

The "December 1921 letter to Mr. Moffat" referred to above, reads as follows:

Dear Mr. Moffat:

I got your letter about the skull.

The following is from my note book: "Old Bone Cave: Skull (which might be either man or monkey) found East side of Incline about 60 ft. level by T. Zwigelaar 17–6–1921.

A mass of small bones (probably bat bones) all around it.

In afternoon of same day big portion of skull with teeth in good condition (apparently lion) found in same place by Angelo. Block P 7."

I gave the above in my report, either fortnightly or monthly, of the period, which could be obtained from the Mine office in Broken Hill.

A spherical stone implement, a collar bone[6] and a lot of casting (fossilised skin or matting) were found practically in the same place.

I have brought away with me none whatsoever of the bones or implements.

The skull, and a number of other fossilised bones which Dr. Wallace (of Broken Hill) considered of special interest,[7] were packed in a box for Mr. Macartney to take to London with him.

There was quite an interesting lot of bones shelved in the office and the tool hut at the mine when I left. Mr. Macfarlane, my assistant, who took over from me, will know of them.[8]

One huge bone which appeared to be the thigh of an elephant or something of that kind, Mr. Macfarlane should have no difficulty in sorting out from the tool hut; an assay of a portion of it gave about 8% Pb. and 4% Zn; it was got from about the 40 ft. level many months ago. Another of special interest is in the Survey Office behind the Engineer's Office; it has the appearance of having been an elephant's hip bone or something of that sort, also from about 40 ft. level.

As the skull which is attracting so much attention was got from the East side of the incline at about 60 ft. level, and a great deal of bone debris is probably still intact in the incline itself, things should be watched with great interest when the time comes for mining away of the incline when hoisting commences at No. 2 shaft.

Yours faithfully,
(Sgd.) W. E. Barron.

Another old employé who was present at the time of the discovery of the "Rhodesian Man" and who saw the specimen shortly after it was discovered could give no details of value. The importance of the find was not appreciated, no special effort was made to go into details, and the incident passed out of memory.

[6]No such bone was remembered by Zwigelaar, and no such specimen is in the British Museum of Natural History. *A. H.*

[7]This phrase deserves a close attention. There is no intimation that these bones were associated with the skull. *A. H.*

[8]This is doubtless one of the lots of bones found by the writer; see later. *A. H.*

The Manager of the mine, Mr. Macartney, remembers clearly the main items relating to the find. He saw the skull shortly after discovery and he also saw the place where it was found. He feels certain that the softer spot in which the skull lay contained quantities of detritus with bats' bones. He also remembers a thick layer (about 30 feet) of very pure and not very solid lead ore that lay between that part of the crevice or cave that contained the skull and the bulk of the cavity which was filled with more or less mineralized animal bones, detritus, etc. There is an uncertainty as to a possible connection of the contents of the two portions of the cave under the ore.

Dr. Wallace very kindly gave the writer a written account of his recollections. They are as follows:

"I only heard about the skull about two weeks after it was found. It was then at the Mine office, and the General Manager, Mr. Macartney, sent it down to my surgery where I had it for three weeks. I am quite sure that the lower jaw was never found. The skull was sent to me with a few other bones in a box. Amongst these bones was what might have been a human tibia. I did not recognize any of the other bones as being of human origin.[9]

Mr. Armstrong, who at the time was the metallurgist here, took a great interest in the skull. It was he who first told me about it. I think that among the bones sent with the skull were two pieces of what Mr. Armstrong thought was some fossilised material that had been wrapped round the body. Mr. Armstrong's idea was that this had been an animal's skin. I think Mr. Armstrong has a piece of this in his possession but I am not sure.

One of the teeth in the skull was loose and could be lifted out. When I sent the skull and the other bones back to the Mine Office I sent the tooth with them."

The writer wrote to Mr. Armstrong who meanwhile has moved to Australia and received from him the following notes:[10]

Sydney, 21st December 1925.

Dear Mr. Hrdlička,

I was extremely pleased to hear from Dr. Wallace of your visit to Broken Hill, and much regret that I was not there. . . . I was informed of the find a few minutes after the skull had been unearthed, and immediately went to the mine and collected all the bones exposed in the immediate vicinity.[11] The bones which were eventually taken to Kensington Museum proved to be (1) part of a human lower (upper) jaw; (2) a human leg bone; (3) a lion's skull.

[9]This is another important statement and made by one well acquainted with human bones. *A. H.*

[10]Certain personal references omitted.

[11]Statements plainly somewhat erroneous. *A. H.*

At the time of the discovery I was in charge of the Works only and had no authority at the Mine. . . No systematic search was made for further important bones and the skull with the bones I had collected was left in the Mines Shelter Office.

In 1922 I left Broken Hill and came to Australia. At the request of Professor Burkitt I called at the Sydney University and gave him particulars of the find. I left the sample to which you refer with him. It was not a bundle (I know nothing of any bundle being found) it was part of a protective covering which completely encased the skull.[11] This had been broken off before I arrived at the mine. The importance I place on this is due to the fact that none of the other bones in the vicinity had any such covering.

In August, 1922, I went to London and called upon Professor Woodward at the Kensington Museum. He showed me the skull and the various bones which had been delivered to him by Mr. Macartney and I recognised the ones which he stated were the lower (upper) jaw, the leg bone and the lion's skull—these were all discovered within a foot of the skull.

I know little of Anthropology, but from the geological point of view and from close observation of the so-called "cave" in which the skull was found, I consider there is proof of a much greater age than the estimate given by Woodward.

Yours truly,

(Sgd.) A. S. Armstrong.

The foregoing documents make it only too evident that the exact details of the rare find were by no one recorded; and that the remembrance of them has in the course of time become more or less confused even in those who were on the spot soon after the discovery. The statement of Mr. Harris in "The Illustrated London News" (see Appendix) made five months after the event is doubtless no less faithful but also no less defective than the others.

Hoping that something more precise might have been given to the British Museum (Natural History), the writer turned to Dr. Bather, the present very good Keeper at that Museum of the Department of Geology and Palaeontology, and was very kindly furnished with copies of all the official entries relating to the find and an earlier collection from the same cave. They read as follows:

Nov. 15th. 1921.
3379 Franklin White Esq.,
11a Harrington Gardens, S. W. 7.

4 stone implements and 3 pieces of worked bone collected by the donor in a cavern in the Broken Hill Mine, N. W. Rhodesia.

Nov. 24th. 1921.
3382 The Directors of the Rhodesia Broken Hill
Development Company, Ltd.
(per Edmund Davis, Esq., Chairman),
19, St. Swithin's Lane, E. C. 4.

A primitive human skull, with part of maxilla of a second skull, a sacrum, three pieces of femora, and a tibia; also 7 associated bones of mammals, and 2 round pounding stones; found in a cavern at the Broken Hill Mine, N. W. Rhodesia.

May 8th. 1922.
3438 Franklin White Esq.,
19 St. Swithin's Lane, E. C. 4.

Collection of stone implements from Broken Hill cave and other localities in South Africa.

As the collective sifted result of the information obtained from all quarters, with the results of the personal inspection of the mine and of what remains of the bone cave, and with the impressions left by the different men associated with the finds, the conclusion is that the real conditions had probably been somewhat as follows:

The "bone cave" was an extensive irregular crevice running for 120–150 feet inward and downward from near the base of the hill and reaching the maximum depth below the surface of about 70 feet.

There is no recollection of the mouth of the "cave" and this may have been covered or obstructed. Inside, the crevice enlarged to a cavern which at its maximum measured probably over 30 feet in breadth and twice as much in height.

For some distance from the mouth of the cavern the floor of the latter was nearly level or but moderately inclined, then there was a steeper descending slope, and after that the crevice ran irregularly downward and inward.

The outer part of the cavern was largely filled with more or less mineralized and consolidated bones of animals, cave detritus, large quantities of bones of bats or small rodents and nondescript earthy material, the walls being covered with crystals of the ores of zinc and vanadium. The larger bones were distributed unequally through the filling of the cave, in some places there being large quantities of them, in others few or none. They extended to and beyond the descent in the floor.

The lowest and innermost part of the cavern was filled by detritus, some bones and by a considerable layer or rather layers of very pure and more or less crumbly lead ore. The ore contained no bones or

foreign substance; but, it is not absolutely known whether the contents of the distal part of the cavern had a direct connection with the materials in the large outer portion through or underneath this lead ore.

The skull was found at some distance beneath a layer—according to Mr. Zwigelaar's recollection about 10 feet thick—of this ore. It was not itself embedded in the ore but in a detrital material not mineralized to any extent, and containing a quantity of "bat" bones.

The skull was an isolated object. It lay upright. There was no lower jaw, nor any other bone in apposition. Beneath it was something which looked like a large flattened skin bundle, thoroughly mineralized. This may or may not have been merely a natural laminar formation of the lead ore. Barring a few fragments it was smelted.

Somewhere in the vicinity of the lower portion of this "bundle" was found a remarkably straight but otherwise not peculiar, full-sized human male tibia, and lower at some distance were portions of a mineralized lion's skull. In the vicinity there may have been found also one or two other human fragments, but here much is uncertain.

The larger part of the bony contents of the main part of the cave were so mineralized that they passed for a good grade of zinc ore and were smelted as such. Various portions of the cave fillings, however, were poorer and were brought out and thrown on a dump where, covered by poor rock and débris thrown out subsequently, they still repose. The ground and débris in the dump are still full of fragments and pieces of bone, with teeth, chips of quartz, etc.

Only traces of the great cave now remain in the mine, and as the work progresses they will disappear. The opposite wall of the mine shows an even larger old cavern, completely filled with less consolidated and somewhat darker materials than the surrounding rock. This cave has given no bones.

FURTHER SPECIMENS

While gathering this information the writer learned casually that some of the loose bones from the bone cave—part unknown—were saved and might possibly still be found in some of the offices and tool huts of the mine. Accordingly as soon as possible a search was instituted in company with Mr. Rudyerd, and before long several lots of such bones were located in the main office, in the designer's room, in another small office and in two small huts near the mine. Those in the main office were in a case with a series of mineral specimens from the mine and represented especially bones enclosed in mineral matrix; the

bones in the other places were loose and not encrusted, only more or less covered with earth and dust. All the bones, however, showed more or less mineralization.

In addition the officials of the Company very kindly gave the services of two "boys," with whose help digging was begun into the old dump, with the result that in two days numerous additional bones and teeth were added to those already located. All this material was then washed, dried, spread out on a large designer's table and sorted.

FIG. 2.

Even before this, however, while handling the dusty bones in the designer's office and in the tool house, the writer had found among them in the former place a large portion of the distal end of a human humerus, and in the hut a piece of a human parietal. Both of these specimens showed the same mineralization as the rest of the numerous bones and were plainly parts of the same lots. As there is not the slightest intimation that these many scores of animal bones, some of them very conspicuous, were found anywhere near the Rhodesian skull, they probably all proceed from other parts of the cave; and as the human bones among them were of the same color and mineralization, there is a strong probability that they were with these bones in the cave. Which means that human bones were found also elsewhere in the crevice, a fact having an important bearing on some at least of the human bones brought to England with the skull.

The total of several hundreds of animal bones proved to be of very considerable interest, and established in a short time the true nature of the bone cave. As they were sorted, bone by bone, it was seen first of all that they represented a very large variety of mammals with some birds and possibly one or two larger reptiles. The mass of the bones belonged to ungulates, but there were also a few carnivora. Nearly all the bones, however, showed characteristic old breaks and cleavings. The skulls and even the horns were all broken into large pieces; the hip bones and shoulder blades were broken much and irregularly; while the long bones, even those of the larger birds, were generally broken at or near their middle, addition to which a number of the extremities of the tibia and femur were cleft in two longitudinally so as to expose the whole

cavity. There were no marks of teeth on the bones, not even of the teeth of rodents, and little of artifacts outside the main breaks. But these breaks were produced, it was seen again and again, not accidentally or by the teeth of animals, or by man's tools sharp cutting and cleaving as ours, but evidently by stone implements.

The lesson was clear. These were the bones of animals utilized for food by some native group of men, and the bones had been purposely and systematically broken by these men to get at the marrow. The horns were broken for the same purpose. Moreover a number of the bones showed more or less the effects of fire; and in several instances there were found two or three pieces of what was originally the same bone, or again two bones proceeding plainly from the same animal. The lower halves of the two humeri of a young hyena, broken in the same manner as others, were among the collection.

All this indicates that the cave had been used for a long time by some group of native population as a habitation, or at least as a trysting place where parts of animals were brought, cooked or roasted and eaten.

Among the bones the writer found a few flakes and a piece of quartz that may have been partly shaped by man. It has a good cutting edge which would have been serviceable.

The main bone cave may therefore confidently be characterized as a cave of prolonged occasional or permanent human habitation in some part of the past, perhaps not very far distant. How far will depend on the identification of the animal forms whose bones were left in the cave. Bones from the outer part of the cave identified previously were, we have seen, practically all of forms that are still living.

The newly found human bones proceed from two skeletons; the arm bone is that of a strong adult male; the parietal, rather thin, is probably that of an adolescent. They apparently have no connection with the "Rhodesian skull." But lying as they did among the broken animal bones, and in the case of the humerus being fractured crosswise by a blow as was the rule with the animal bones, a suspicion is aroused that they may have belonged to human beings who suffered the same fate as the animals. The new evidence throws no light either upon the racial character or the antiquity of the remarkable cranium.

THE BONES IN ENGLAND

The two new human fragments, the mammalian teeth and a selection of the animal bones were deposited by the writer, together with a quartz ball and the above mentioned stone, in the British Museum (Natural

History), South Kensington, so as to be with the Rhodesian skull and the other specimens collected previously. On this occasion the writer was able once more to examine the Rhodesian skull, and also the other human bones that were received with the skull. They are, a portion of a separate upper jaw with two teeth; a tibia; two parts of a male adult femur; one shaft of a female adult (?) femur; a large part of a right female (large notch) *os coxae;* a large part of a male ilium (small notch) and one sacrum. Of these the upper jaw, mineralized, is somewhat different in color from the skull. While it is considerably heavier than normal, morphologically it is in all ways like the jaw of a modern negro, with modern teeth, and bears no resemblance to the corresponding part of the skull. The tibia is much more reddish-brown than the skull; the female femur is light ochre-yellow; the male femur pale to blackish-brown with thick walls. One of the pelvic parts is near in color to the skull, the other is distinct.[12] The male femur is in two parts with the middle portion missing; the breaks are old and both fragments show superficial slivering from knocks. The writer feels strongly that these bones should not be associated with the Rhodesian skull. They are all and in all respects of modern form and size. They may belong to the contents of other parts of the cave, or at least to entirely different human beings. They all, with the exception of the tibia, are broken (old breaks), which may be indication of cannibalism. At least it may be said that it would be unsafe, before further evidence may throw more light upon the matter, to build on the basis of these bones any conclusions as to the skeletal characters of the original owner of the Rhodesian skull.

THE RHODESIAN SKULL ITSELF

Although four and a half years have elapsed since the discovery of this highly remarkable and enigmatic skull, no thorough report of the

[12]In this connection the writer is glad to print the following letter referring to something that may but apparently does not wholly account for the differences in color and consistency of the bones (particularly one of the femurs) in question:

Department of Geology, British Museum (Natural History)
2 March 1926

Dear Dr. Hrdlička:
I have just had occasion to read your letter of the 12th November 1925, addressed to Dr. Bather. In it you state that the skeletal remains from Broken Hill differ from the skull and from each other in colour and state of mineralisation. May I point out that this is not really the case, and that the reason for varying colour is a difference in method of treatment by the preparators? The skull was painted over with a thin solution of shellac soon after it was received here; this darkened the colour a little. The remainder of the bones, with the exception of the two innominates, were soaked in "wulfite" about 12 months ago. This caused the dark colour and also increased the weight very considerably. The innominates have not been treated in any way; they represent the original condition of all the others.

Yours truly,
(Sgd.) Arthur T. Hopwood

MEASUREMENTS OF THE RHODESIAN SKULL

	Elliot[1] Smith	Smith[2] Woodward	G. L. Sera[3]	Eugnee Dubois[4]	Arthur Keith[5]	Hrdlicka (new)
Vault:						
Capacity, cc.	1280	abt. 1280	—	1400 (estim.)	1305 (displacement of intracranial cast) 1370 (estim. from ext. measurements)	—
Length Maximum	—	abt. 21.–	21.– (prob. after S. Woodward)	—	21.–	nr. 20.8
" glabella-inion	—	—	—	20.7	—	—
" ophryon-maximum[6]	—	—	—	—	—	19.9
" less frontal and occipital bulgings	—	—	—	—	18.6	—
Breadth maximum	—	abt. 14.5	14.5 (prob. after S. W.)	14.5 (prob. after S. W.)	14.5 (prob. after S. W.)	14.8[7]
Height, basion-bregma	—	—	13.1	13.–	—	13.–
" auricular line-vertex	—	—	—	—	10.7	—
Cephalic Index	—	*69.–*	*69.–*	*70.–*	*69.–*	*71.2*
" " with ophryon length	—	—	—	—	—	*74.4*
" " corrected[8] length (Keith)	—	—	—	—	*78.–*	—
Mean Height Index (with length to ophryon)	—	—	—	—	—	*74.9*
Intracranial:						
Length (mean of the two hemispheres)	—	—	—	17.1	17.1	—
Breadth maximum	—	—	—	13.4	—	—
Height (basion-vertex)	—	—	—	12.2	—	—
Intracranial Index	—	—	—	*78.4*	—	—
Face:						
Height, Alveolar pt.-nasion	—	—	—	9.2	—	9.5
Breadth, bizygomatic maximum	—	—	—	—	—	abt. 14.8 (½ = 7.4)
Breadth, from notch (or angle) to notch on the temporal border	—	—	—	13.4	—	13.6
Breadth, across the angular processes of the frontal	—	—	—	13.9	—	—
Facial Index, anatomic	—	—	—	—	—	n. *64.2*

Nose: Height	—	—	—	—	—	5.9
Breadth	—	—	—	—	—	3.1
Index	—	—	—	—	—	*55.4*
Orbits: Height (mean)	—	—	—	—	—	3.9
Breadth "	—	—	—	—	—	4.3
Index "	—	—	—	—	—	*90.7*
Diameter frontal minimum	—	—	—	10.4	—	—
Height of alveolar process (subnasal pt. to alveolar pt.)	—	—	—	—	—	3.7
Basion-nasion	—	—	—	11.1	—	11.1
Basion-subnasal pt.	—	—	—	—	—	10.1
Basion-alveolar pt.	—	—	—	11.7	—	11.8
Basion-inion	—	—	—	9.9	—	—
Facial angle (between basion-alv. pt. and alv. pt.-nas. diameters)	—	—	—	—	—	62°
Alveolar angle	—	—	—	—	—	54°
Palate: (dental arch)						
External length (max.)	—	—	—	—	—	7.–
" breadth "	—	—	—	—	—	8.5[9]
Index	—	—	—	—	—	*82.4*
Length to back of 3rd molars	—	—	—	5.95	—	Max. ht. nr. 1.8
Length "from socket of median incisors to a line drawn across back of 3rd m's"	—	5.1	—	—	—	—
Breadth "outside measurement across the 2nd molars"	—	7.8	—	—	—	—
Width bet. the sockets of the 3rd molars	—	5.1	—	—	—	—

[1]Smith (G. Elliot)—The Rhodesian Skull. *Brit. Med. J.*, Feb. 4, 1922, 197–8.
[2]Smith (A. Woodward)—*Nature*, Nov. 17, 1921, 371–2; and *Sci. Progress*, 1922, XVI, 574–9.
[3]*Riv. Biol.*, 1922, IV.
[4]*Trans. K. Ak. Wetensch.* Amst., 1922, XXIV, 326 *et seq.*
[5]The Antiquity of Man. 2nd ed., 1925, II, 386.
[6]From a pt. 3.5 cm. above nasion (comp. glis.); from a pt. 2.8 above nasion = 20.2.
[7]14.5, repeated probably by authors after Smith-Woodward seems erroneous; two separate measurements with a well-tested instrument gave the writer 14.8 (14.7–14.8) and the fine cast of the skull on which the other measurements are, exceptionally for a cast, correct, measures also 14.8 cm. (or 14.75). In its perfect state, before an injury to the right lower portion of the vault, this measured surely 14.8, if not a trace over. It is probable that the original and then simply repeated low measurement was due to an inaccuracy of the instrument, which is only too common.
[8]$\frac{H}{(L+B):}$
[9]Alveolar process shows externally some swellings without which the breadth would be about 8.1; index *86.4*.

specimen has yet been given. It was expected that Professor Smith-Woodward, who gave two preliminary notices of the find,[13] would prepare such a report, but this now seems uncertain. Notes on the skull were published later by Eugene Dubois,[14] Sera,[15] Martin,[16] Hambruch,[17] and Boule,[18] while Elliot Smith[19] commented mainly on the brain.

The most complete account of the specimen so far published, however, is that of Sir Arthur Keith in the recent second edition of his "Antiquity of Man;"[20] but unfortunately it includes some of the misinformation about the circumstances of the discovery (p. 382, upper paragraph) with its consequences.

The writer does not wish to anticipate the complete description of the specimen by his English colleagues. But he has been kindly allowed to take a few measurements on the original which may be of service before the final data become available. These measurements, with those previously published by others, are given in the accompanying table. The specimen is difficult to measure, which, with instrumental imperfections doubtless accounts for some of the differences in individual determinations.

SUMMARY AND CONCLUDING REMARKS

The Rhodesian find of 1921 is more complex than has been generally appreciated. Due to the absence on the spot of any scientific man exact details of the find have not been ascertained. Of what was learned but little was recorded, and of the rest much has since become confused. The precise circumstances of the discovery are therefore, and must remain, deficient.

The main part of the bone cavern was for a long time a habitat or a feasting place of the ordinary Africans, bushmen or negro. The larger bones were none of them brought in by animals, but were the remains of

[13]Smith-Woodward (A.)—A new Cave Man from Rhodesia, South Africa. *Nature*, 1921, CVIII, 371–2; The Problem of the Rhodesian Fossil Man. *Sci. Progress*, 1922, XVI, 574–9.

[14]Dubois (Eugene)—On the Cranial Form of *Homo Neanderthalensis* and of *Pithecanthropus erectus* determined by Mechanical Factors. *Konink. Akad. Wetensch.* Amsterdam, 1922, XXIV, 313–332.

[15]Sera (G. L.)—*Rivista di Biologia*, 1922, IV, 2.

[16]Martin (R.)—Der neue Schädelfund von Rhodesia. *Mannus, Z. f. Vorgeschr.*, 1922.

[17]Hambruch (P.)—Der Schädel von Broken Hill Mine in Nord Rhodesia. *Arch. f. Anthropol.*, 1923, N. F. XIX, 52–56.

[18]Boule (M.)—Fossil Man, 8°, Edinburgh, 1923, 481–6.

[19]Smith (G. Elliot)—*Brit. Med. J.*, 1922, I, 197; *Atlantic Monthly*, Apr., 1922.

[20]London, 1925, II, 377–393, 5 illustr's.

See also "The Sufferings of the Rhodesian Man," *Lancet*, 1922, 1206–7; and Siffre—"L'Ineptitude dentarie des hommes préhistoriques." *La Semaine dentaire.* 1925, VII, Nos. 12 and 13, 300–8, 322–8.

the repasts of the black man. A very large majority were broken for the marrow. Similarly broken human bones suggest cannibalism. There were apparently no human burials in the cave. How the strange Rhodesian skull got in is unexplainable.

The skull was found alone in the lowest and most remote part of the cave, some distance beneath considerable accumulations of soft pure lead ore. There was no lower jaw. There was no skeleton. One human bone, the tibia, and parts of a lion's skull, it is well established, lay from a few to about ten feet from and at a lower level than the skull.

As to the other human bones deposited at the British Museum with the skull and those now added, all that may be said is that they proceed from several skeletons of modern size and form; that some of them, at least, probably came from other parts of the cave; and that there is no proof, and but a remote possibility, of any of them belonging to the skull.

The skull itself is positively not the skull of any now known African type of man or their normal variants. Neither is it any known pathological monstrosity, such as gigantism or leontiasis. It is a most remarkable specimen of which the age, provenience, history and nature are still anthropological puzzles.

Morphologically the skull is frequently associated now with the Neanderthal type of Europe. This may be fundamentally correct, but only to that extent. In its detailed characteristics the specimen in some respects is inferior, in others superior to anything known as yet of the Neanderthal man.

Meanwhile mining operations at Broken Hill are proceeding. They will gradually do away with what may still remain of the former bone crevice; and they will soon, if they have not already, involve the second kopje with its crevices. All this work should be intently watched, for any day it may uncover new evidence of much importance.

APPENDIX I

Abstracts from Original Reports on the Rhodesian Cave

1907—Mennell (F. P.) and E. C. Chubb. On an African Occurrence of Fossil Mammalia Associated with Stone Implements.[21]

"Our investigations have been chiefly based on specimens in the Rhodesia Museum presented by the Broken Hill Company, Mr. Franklin White, Mr. Marshall Hole and others, as well as on other material for the opportunity of examining which we are indebted to Mr. White and to Mr. F. G. Colvile.

The Rhodesian Broken Hill Mine is situated about 150 miles north of the Kafue River in North-Western Rhodesia. It contains extensive zinc and lead deposits which have a prominent outcrop in the shape of two small hills or "kopjes" rising out of a "vlei" or swampy flat. The surrounding country is chiefly limestone, which is associated, in proximity to the ore-body, with schistose rocks, evidently altered sandy and shaly sediments, together with crushed bands of the limestone itself. There is granite not many miles distant, but the ores do not appear to have any direct connection with an igneous rock; they seem rather to be related to faulting and shearing of the limestone at its junction with the schists. Surface specimens of the limestone are usually somewhat coarsely crystalline, and white or grey in color with few impurities save quartz. Lower down in the workings they are often black or reddish in color and closely resemble the Carboniferous Limestone of Somersetshire. Under the microscope, however, they differ *in toto*, having a foliated structure in even the most compact-looking specimens. It is probable therefore that the sugary appearance of the outcropping rock is due to some form of surface alteration. It cannot be attributed to pressure or contact metamorphism, as it would in that case be just as apparent below ground as it is above. The limestone is highly magnesian and sometimes approaches a true dolomite in composition. No definite silicate minerals can be detected under the microscope.

The feature of the ore-body with which we are now chiefly concerned is the extraordinary accumulation of mammalian bones in No. 1 Kopje. Beautifully crystallized phosphatic minerals have also been found in No. 2 Kopje, but although it would seem a natural inference that they are due to the interaction of the metalliferous solutions with the lime phosphate of bones, none of the latter have been met with. The amount of bones in No. 1 Kopje is enormous. They occur in the central part of the kopje and almost continuously beneath it, below the level of the surrounding flats. It would appear that the bone deposits represent the infilling of a large cavern in the limestone, perhaps with a kind of swallow-hole leading down from the top of the kopje, though there is no actual opening at the present time. It is difficult from the data at present available to determine with any certainty the relative ages of

[21]Proc. Rhodesia Sc. Ass., Bulawayo, VI, 1907.

the different layers of bones, but their accumulation must have taken a very long period of time. There are masses of bones almost free from other substances, and there are interspersed muddy layers containing zinc compounds, but free from bones. Much of the material, however, which shows no large bones, yields on disintegration innumerable bones of rats, shrews, birds etc. The bones are in nearly all cases partly or wholly converted into zinc phosphate (hopeite?). They are therefore truly fossil, the organic matter having disappeared and having been completely replaced by mineral substances. Vughs in the deposit are often lined with magnificent crystals of the rare mineral hopeite and they also show at times more or less dendritic coatings of a substance which at first was taken for amorphous zinc phosphate, but which is rich in vanadium and may really be a calcium vanadate. The new triclinic zinc phosphate "tarbuttite" occurs in No. 2 Kopje with cerussite, hemimorphite, hopeite, pyromorphite and vanadinite or descloizite, and does not seem to be found in the bone deposit.

The bones make up vast accumulations of isolated broken fragments. Whole bones are the rarest exceptions, and are exceedingly difficult to extract even when discovered. There never appear to be a number of bones belonging to the same aminal occurring together, as would be the case if they had died naturally on the spot or been accidentally engulfed, in the way suggested for the well-known occurrence at the Winnats, Castleton, Derbyshire. It seems certain that the deposits as a whole represent the materials accumulated during alternating occupations of the original cavern by animals and human beings, with intervening periods when the cave was untenanted probably owing to flooding with water. The animal occupants were such as are found together in the Rhodesian caves of the present day, namely hyaenas and porcupines, no doubt accompanied by owls and bats. Some of the bones show signs of having been gnawed by hyaenas, and there can be little doubt that many of them were dragged into the place when it served as a hyaena den. Most of the smaller bones are probably to be accounted for in a somewhat similar fashion, the rats, shrews, etc. having formed the prey of owls and the bones having been ejected in the usual pellets after the birds had assimilated the more digestible portions of the bodies. An examination of modern owl pellets entirely confirms this view, as these latter show the same predominance of head and leg bones as do the washings of the Broken Hill deposit. As usual with mammalian remains, lower jaws are particularly prominent. Those parts of the deposit which contain implements, no doubt owe their accumulation in great part at least to human agency, the bones being relics of the food supply of the ancient inhabitants. It may at once be stated that the contemporaneity of the implements and bones is entirely beyond question. Masses of the deposit full of bones when disintegrated by soaking in water, are found to contain embedded implements. These latter are of a rude order and mostly made of quartz, owing of course to the absence of any more suitable material in the vicinity. There seems to be a strong prejudice in England against the genuineness of implements

made of quartz, and it may therefore be well to emphasize the fact that some are made of chert brought from a distance, and it may also be well to point out that quartz is a very common material for Bushman implements, which the Broken Hill ones much resemble. Knives, scrapers, and grooved scrapers are the common types. Some of the bones show indications of having been cut previously to their mineralisation, as if to make implements, though no finished bone implements have so far been brought to light. One tibia of a moderate-sized ungulate in the Rhodesia Museum has had a nearly circular hole made in it prior to its replacement by zinc salts. This may be attributed to a wound from an arrow of the Bushman type or it may have been bored with a view to making an implement or ornament: in either case it must be due to human agency.

With regard to the age of the deposit it must represent a long period of time in all, but it will be noted from the subjoined list that nearly all the bones appear to be referable without much doubt to recent species inhabiting the country at the present day. It is probable, however, that some may represent closely allied but really ancestral forms, and this certainly appears to be the case with the species of *Diceros* (rhinoceros) of which two well-preserved bones are now in the Rhodesia Museum. It is unfortunate that we are not in possession of skulls or teeth of this animal, but we think there can be little doubt as to its being new, and it has therefore been thought well to give it a name for convenient future reference.

The mineral condition of the bones and the obvious changes in the physical features of the locality since the deposit was formed are entirely in accord with the idea of its being of very great age from an anthropological point of view. There consequently appears to be every justification for our belief that the evidence affords the strongest presumption of the great antiquity of man in this part of the world, and that further investigations, which we hope shortly to undertake, will reveal even more convincing proof on this head.

List of Vertebrate Remains

BY C. E. CHUBB

The following is a list of the vertebrates represented by teeth or bones, and identified as accurately as is possible with the scanty material at my disposal for comparison. "R. M." after a description indicates a specimen in the Rhodesia Museum.

Mammalia

INSECTIVORA

An almost complete skull, two or three upper jaws, and numerous lower jaws of shrews. (R. M.)

CARNIVORA

Felis leo, Linn. A right ramus and a few odd teeth.

Felis spp. The canine of an animal about the size of a leopard, and one about the size of *Felis ocreata*. Also two lower jaws apparently belonging to *Felis serval*.

Hyaena sp. A right ramus belonging to a hyaena, but it does not agree exactly with *H. crocuta*. (R. M.)

Viverridae. The right ramus of a member of this family about the size of a large genet.

RODENTIA

Tatera sp. Several upper and lower jaws. (R. M.)

Otomys sp. A number of lower jaws showing the characteristic laminated molars and grooved incisors. There are also one or two odd incisors and molars. (R. M.)

Mus spp. Great numbers of lower jaws and a few portions of upper jaws belonging to several different-sized species. (R. M.)

Bathyergidae. A right ramus without teeth, approximating to *Georychus capensis* in size. (R. M.)

Hystrix sp. A complete ramus and an odd incisor.

UNGULATA

Phacochoerus aethiopicus, Pall. A right upper tusk and a portion of an upper tusk, showing scraping and chipping by human agency. A lower tusk.

Elephas africanus, Blumen. The proximal portion of a humerus, and part of a scapula.

Diceros, Gray. Two complete bones, a left humerus and a right tibia, of a rhinoceros excavated by Mr. Franklin White, were presented by him to the Museum. (R. M. No. 546) On comparing these with bones of the modern D. *bicornis* I find they differ so materially as to warrant their recognition as belonging to a distinct species. This may be known, after the discoverer, as *Diceros whitei*, sp. nov.

Diceros whitei, sp. nov. The humerus of this species differs most remarkably from that of D. *bicornis* in the shape of its distal end. The olecranon fossa is very much narrower than in D. *bicornis* being 29 mm. in diameter, as compared with 51 mm. for a specimen of the latter. Indeed, the whole bone, although evidently that of a fully adult individual, is smaller and much slighter in proportion to its length, which is 330 mm. from the trochlea to the head of the humerus, while D. *bicornis* measures 358 mm. The tibia, although not differing to the same extent as the humerus, is nevertheless slightly narrower in proportion and a little shorter. This species is evidently a form of rhinoceros smaller and less heavily built than D. *bicornis*. For this reason it is also distinct from D. *simus*, and from D. *simplicidens*, Scott. which is likewise larger than D. *bicornis*. I hope shortly to publish figures showing fully the differences between the species.

Equus sp. Several molars probably belonging to a zebra.

Connochoetes taurinus, Burch. The basal portion of a horn-core.

Strepsiceros strepsiceros, Pall. An imperfect horn-core.

Taurotragus oryx, Pall. Portion of a horn-core.

In addition to the above there are in the Rhodesia Museum a number of bones and teeth of various other antelopes, not identifiable with certainty.

AVES

An incomplete pelvis of a small bird, an ulna and several leg-bones.

AMPHIBIA

The ischial portion of a frog's pelvis; also an astragalus and calcaneum.

Further Notes

1908.—A second and even more intimate report on the Broken Hill cave soon follows (September 26, 1908). It is a communication by Engineer Franklin White, at that time employed by the Broken Hill Mining Company, to the Rhodesian Scientific Association.[22] The paper, the title of which is "Notes on a Cave Containing Fossilized Bones of Animals, Worked Pieces of Bone, Stone Implements and Quartzite Pebbles, Found in a Kopje or Small Hill Composed of Zinc and Lead Ores at Broken Hill, North-Western Rhodesia" gives in the main the following information:

"The geological formation is limestone with some beds of sandstone conglomerates and phyllites. The country in general is very flat, excepting where the sandstone ridges rise a few feet above the general level. . . Around Broken Hill, however, there is a series of kopjes or small rugged hills composed chiefly of ores of zinc and lead, the top of the highest (No. 2) being about 90 feet above the ordinary ground level. . . . The outcropping zinc and lead ores have been much weathered, forming crevices, rough crests and ledges which at times are sufficient to form lairs for wild beasts, or even to afford a slight shelter for human beings, such as Bushmen, but nothing which can be properly called a cave has been found from the outside of these kopjes neither are there any indications of blocked-up entrances to passages or caverns. Owing to the flat nature of the country, the water in the rainy season stands in numerous pools and can be found in shallow excavations a foot or two in depth. During the dry season the numerous crevices in the limestone afford passage for the water to drain off and the natural water level is then about 18 feet below the ordinary surface. There is therefore an annual rise and fall in the water level underground which will vary according to the rainfall, which is from 23 to 40 inches per annum, the wet months being November to March. . . . A deposit of fossilized bones, teeth and cores of horns had however been found on the Northeast side of the hill when a large quantity of carbonates of zinc, lying on the flank of the hill, was quarried away. The bones were found in a layer of sandy clay about four feet thick, the top being about 3 feet below the surface level.

Beneath the bone layer was a stratum of damp clay, and this rested on ore of the ordinary class. This bone deposit was quite covered over by calamine ore. The bones were highly mineralized, the phosphates of lime being converted into phosphates of zinc. The fragments found were very small, seldom being obtained more than six inches long and

[22] *Proc. Rhodesia Sc. Ass.*, VII, 1908, Part 2, 13–21.

were not at all in well defined layers. The northern end of the deposit has not yet been excavated. A lower tunnel 17½ feet below the others, was driven later on from the south west to north east right under the hill, the entrance being from inclines commencing some 20 feet away from the foot of the slope of the hill. At 34 feet from where the tunnel began, the solid ore was replaced by a mixture of rather dull yellow clay in which were embedded numerous fragments of broken bones, teeth and cores of horns of animals and splinters and flakes of white quartz. It was considered advisable to ascertain how much space was taken up by this mixture of clay and a cross-drive or tunnel was made towards the north west extending for 44 feet. The tunnel reached a face of solid ore dipping steeply to the north west. No examination was made on the south eastern side of the lower tunnel. A cross tunnel was then driven westwards from the main or surface adit, at 45 feet from the entrance, and at 25 feet the cavity was again reached the top being nearly level with the tunnel. The width from east to west was thus shown to be some 24 feet. The length, on a line running nearly north and south is at present proved to be 80 feet.

Description of the Cave. This cannot be given very completely at present as the work of excavation is suspended for a time. The north western end at the lower level, and the south eastern end at the upper level are exposed, and the position of the north eastern edge can be fairly accurately determined by the points of intersection at the lower tunnel, by the cross-drive, and by the fact that the southshaft is in solid ore. The south western edge is still undetermined.

There is clay and earthy material still in the bottom of the cross-drive at the end. There are only a few pieces of bone below a line drawn 4 feet above the floor, or say 13½ feet below the surface level. This may be due to the permanent water level being close by and therefore this portion of the cave would be less frequently occupied. The black earthy and clayey materials forming the lower half of the cross-drive are in distinct layers. In one layer were found some small lumps of sulphide of lead which had apparently been formed there. A section of this end of the cave and its filling shows the following features: The layer, in which bones are most abundant, dips a little to the south east. Present roof of cave. This is composed of a soft, easily disintegrated clay, in which lie pieces of quartz, broken bones of larger animals and innumerable little bones of small animals, some of which have been identified. The roof is thickly studded with beautiful clear white crystals of phosphate of zinc (hopeite). Towards the north another class of small crystals becomes frequent. These are dull red or brown and resemble short moss. The solid face of ore is covered with them. The yellow clay stratum comes within about 1½ feet from the roof and with the aid of a strong light it can be seen that this open space extends for some distance upwards. On top of the clay, crystals of phosphate of zinc are also numerous. In the clay stratum pieces of bone, teeth etc. are in large numbers and in the side of the tunnel a piece of a large bone some 8 inches wide was found. Below the yellow stratum the filling lies in

very distinct thin layers which however do not run evenly, but dip in several directions as shown. A thin seam of carbonate or lime crystals runs downwards through this filling which is of a blackish colour and corresponds to the residue which would be left from the decomposition of limestone. The fragments of bone became very scarce towards the bottom of the tunnel. It will be noticed that the filling in of the tunnel has receded or settled down from the roof and back from the end of the cave.

Another noteworthy feature is that the roof at this place is neither ore nor limestone but clay and with it are mingled innumerable small bones and also some pieces of large bones. These facts will be referred to later in the paper. The portion of the cave exposed in the tunnel from the upper drive presents some different features. The roof is limestone, the bone layer is not so thick but the bones are larger. They lie on a bed of soft black debris, are considerably altered, evidently by contact with zinc bearing solutions and are coated with a thin blackish film which cements them together so firmly that great care is required to separate them from each other. The bones identified as a species of rhinoceros were found here in a position which indicates that they must have been thrown in as it were in a corner. In no instance do the bones lie in such a manner as would indicate that they formed part of an entire animal. They are generally broken, but show no signs of having been gnawed by carnivora. On the other hand there is distinct evidence that the cave was occupied by human beings of a very low type.

Evidences of Human Occupation. These can be summarised as follows: Stone implements, chiefly flakes of white opaque quartz, not at all suitable for such purposes, some nevertheless showing distinctly the chipping, cutting or scraping edges and notches. Implements of a close grained reddish stone, one being distinctly serrated. Bones showing cuts or notches, one being chipped into a rough hexagonal form. Pieces of bone, ivory or horn, shaped as if used for digging roots. Large rounded pebbles of quartzite which must have been brought from a distance and were probably used for breaking up marrow bones. The size of some of the bones and position and manner in which they are found makes it very improbable that they are the remains of animals which have died in the cave from natural causes or have been dragged in by beasts of prey.

Formation or Origin of the Cave and its Subsequent Filling in. Although, in view of the little exploratory work done, it is rather premature to advance theories regarding these points, the following suggestions may be put forward as affording a possible explanation. The well defined, nearly vertical face of solid ore which forms the north west end of the cave may be the result of subsidence caused by the ore or rock below having been dissolved away by underground currents of water, or by thermal springs. This large cavity having been formed, it may have become filled up by clayey matter, bones etc. washed in from above, and a subsequent subsidence having taken place, a portion of the filling may have remained behind, thereby forming the roof of the present

cave. No entrance has been found, although the southern face of the hill has been scraped clean in benches in taking away ore.

The second filling up of the cave may have been as follows: In the yearly rise and fall of water due to the recurring rainy and dry seasons, the fine particles remaining from the disintegration of the limestone would sink down until the bottom was raised to such a level that it would for a great part of the year serve as a habitation for human beings. During each rainy season the rising water would force the inhabitants to retire or occupy the upper part of the cave, and season by season fresh layers of bones, rubbish, stones etc. would raise the floor still higher.

The entrance may not yet have been discovered, it may be small. It may have been blocked up by falls of rock or covered over by gradual deposition of ore from solutions, as was the case with the bone deposit on the eastern side. It is probable that the entrance was closed up in some way, and that gradually the earth, clay and bones forming the floor or filling settled down and receded from the sides and roof during the recurrent dry seasons. During this period the beautiful crystals of different minerals already referred to, would be deposited from the solutions permeating the mass of ore in the hill. . . Many of the animal remains have been examined in the Rhodesia Museum by Messrs. F. P. Mennell, the Curator, and Mr. E. C. Chubb, the Assistant Curator with the result that the following identifications have been made."

Mr. White's communication is followed by Mr. E. C. Chubb's "List of Vertebrate Remains" from the cave (already given), and to this is added a Discussion which brings out or accentuates a number of further points of interest:

"Mr. Marshall Hole: What interested me and probably many others in the room most was the evidence afforded on the immense antiquity of man in South Central Africa. I paid a visit to the cave in June of the present year and was struck by the fact that the chipped implements of which I found and brought away several specimens, were confined to a small portion of the cave and that the deepest. I also found a bone which had been perforated probably for use as an ornament and this is now in the Bulawayo Museum.

Father Goetz asked: (1) In what part of the cave were the stone implements found? (2) In what part of the cave were the bones of the extinct animals found? (3) How was the cave formed? Was it not a subterranean cave whose top had fallen in, so that the filling up had come from above?

Mr. Colville: I believe the extinct species was found in the upper level in which the greatest number of large bones are found. The stone implements lay thickest in the lower level anywhere where bones were found but there were also some near the large bones in the upper part. I think it likely that at different periods the cave was occupied by humans and then abandoned for some reason when hyaenas and other animals would occupy it, then probably by humans again for a period and so on for ages.

Mr. Chubb: Among the bones examined by me and which have now gone to the British Museum there was one at least which appeared to show evidence of having been gnawed by hyena; I suggest that for a certain period the cave may have formed a hyena den. This would account for a certain amount of the larger bones found in the cave. But to account for the small mammal remains I think that the cave might possibly have provided a roosting place for owls and the pellets of bones which these birds throw up, accumulating for years would yield a great quantity of remains. On the other hand it may be that a large area of surrounding country had been subjected to sudden flooding, in which case all the smaller terrestrial animals would be drowned and carried away by the torrent which might have led into the cave; and the water then draining through would leave the bones behind. It is well known that in the valleys of some of the large South American rivers all the small mammals are often killed in this way.

Mr. Mennell: The paper is of much interest as dealing with the first instance out of Europe and the Mediterranean region of stone implements being found in association with extinct animal remains. Besides the rhinoceros described by Mr. Chubb the jaws of lion and hyena from the deposit did not altogether agree with modern examples and it is quite possible that a number of extinct species will be found."

APPENDIX II

The Finding of the Broken Hill Skull[23]

THE MYSTERY OF THE GREAT BONE CAVE

The ancient skull which has just recently arrived from Rhodesia and has excited the keenest interest in scientific circles, was unearthed at a depth of 60 feet below water level in the Rhodesia Broken Hill Development Company's mine at Broken Hill, Northern Rhodesia and has been presented by the proprietors of the mine to the British Museum.

No little excitement was caused in the far-away mining camp when it was known that a skull had been found in the mine, and many heated discussions took place among the miners, as to whether it was a large ape's skull or that of a human being. The native laborers were not so interested however; so after the native foreman had sent the skull to the "white boss" they went on with their digging, and so broke into pieces what would have been a far more important discovery, that of the complete skeleton of this early ancestor of man. It was after the manager of the property had seen the skull that it was decided to put it aside and make a search for further remains, and so we were able to recover a leg bone, collar bone, portion of shoulder blade, also portion of the pelvis with coccyx attached, and part of a lower jaw, together with various parts of other bones not identified, and most of the pieces of the mineralised cast of the body. The only other large bone found near these human remains was a smashed skull of an animal similar to a lion; also a round stone similar in shape and size to the stones the present-day natives use for various grinding purposes.

[23]By William E. Harris, "The Illustrated London News," Nov. 19, 1921, p. 680.

One can easily imagine a fight to a finish between man and beast in those far-off, dim ages.

The mine, which is at present an open quarry, has been famous for its "Bone Cave" amongst geologists and travellers for some years, and is situated some 650 miles north of Bulawayo. It was at the foot of this "Bone Cave" that the skull and other human bones mentioned were found, constituting the only human remains out of the many hundreds of tons of bones that have been removed during mining operations. Fossilised and partly fossilised remains of elephant, lion, leopard, rhino and hippo, also of antelope and other cattle, together with tons upon tons of bones of small animals and birds, have been found. The writer has stood at a place where this "Bone Cave" has been cut through and has pulled out from the débris various fossilised bones, such as jaw bones, skulls of small animals and teeth all of which were destined to be passed through the smelters to obtain the metals which have replaced the lime of the bones; for chemical examination has shown that the lime has been largely replaced by the phosphates of zinc and lead.

The discovery of this skull is made doubly interesting when the mine and particularly the "Bone Cave" itself are considered. Before mining operations commenced, there stood at this spot a kopje or hill 50 to 60 feet high, with a slight depression in the centre. Mining operations have demolished this hill, and have excavated to the depth of over 90 feet below ground level where the hill stood, and it was at this depth that the skull was discovered. The entrance to the "Bone Cave" was at ground level. One of the early prospectors who visited it before mining operations commenced, has described the cave as being practically filled with débris. After one had crawled over this obstruction and stood upon the floor of the cave proper, it could be seen that bones of various animals were scattered all around. The floor was made of loose débris and fairly dry. The walls and roof were studded with crystalline deposits, which, when lighted up with the rays of a candle or lamp, reflected back the light, making a veritable fairy cavern, whilst bats and owls, disturbed by the unaccustomed lights, flew around, much to the visitors' discomfort.

It is believed that the cave extended some 120 to 150 feet in a horizontal or slightly dipping direction, from west to east. The walls and roof consist of dolomite and zinc silicate, the floor of loose material to a depth varying from 4 to 12 feet, consisting almost entirely of fossilised or partly fossilised remains of animals. Under this carpet of loose material is rock similar to the walls and roof. Thirty feet below the level of the entrance of the cave is the original water level. At about 10 feet below water level, the cave takes a decided dip, and is filled to the roof with loose débris. At 40 to 50 feet the walls have disappeared altogether, and the bones are surrounded with a soft, friable, lead-carbonate ore. As this constituted the main body of the ore around the lower portion of the cave, the theory has been put forward that the zinc in the ore has been leached out by the action of water and so caused a general subsidence which would account for the depression on the

top of the original kopje and also for the subsidence of the cave from its supposed original horizontal position.

How did these bones get into this cave and how long have they been accumulating? How did the skull and other bones of the skeleton, the only human remains found there, come to be at the toe of this cave, with tons upon tons of bones above them?

One prominent geologist has suggested that the bones have been placed in the cave by human agency. In amplification, another suggestion has been that the original cavern may have been an extremely ancient mine-shaft which was later used as a dumping pit for animal refuse by a tribe of hunters. But the obviously great antiquity of the skull would discountenance the mining theory, while the enormous quantity (some hundreds of tons) of animal bones and the fact that more than 90 per cent of them are so small that the animals must have been far too little to serve as food for human beings, rather tends to cast doubt on the dumping theory.

Another theory, that these bones have been washed into the cave by periodic floods at the times of rains, cannot stand, as all the bones are loose and not cemented together with mud, as might be expected if they had been washed off the surrounding veldt. Also, where could such masses have come from?

The theory that these animals were engulfed whilst taking refuge from some natural upheaval, such as fire or flood, is likewise untenable, inasmuch as at the toe, where the skull was discovered, apart from the skull only small bones have been found. The larger bones were deposited nearer the mouth, and from their condition must have been a far more recent deposit than that of the skull or surrounding bones.

Truly, the whole subject is an astounding mystery.

HUMAN METAMORPHOSIS

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STATEMENT OF PROBLEM

It is commonly stated that there are two kinds of development, direct or indirect, or better, continuous and discontinuous (without and with metamorphosis). Examples commonly cited are man, on the one hand, and a lepidopteran or a frog, on the other.

What is meant by continuous growth? It may be defined as growth which proceeds uniformly in accordance with a simple law from the fertilized egg to the adult stage, where growth in size stops. Such a simple law would be one in accordance with which the increments during a stated time might be equal—constituting an arithmetical law of growth (Fig. 1, Arith. 1, Arith. A); or the growth might increase uniformly and the increments remain constant—constituting a simple geometric law of growth (Fig. 1, Geom. I, A); or the growth might follow the autocatalytic formula so that increments increased and diminished again like the ordinates of the binomial frequency curve (Fig. 1, Autocat. I, A); or indeed it may be of some other type; or the type may change during development.

Precise measures of growth have been made on too few developmental series to afford much comparative material. But, as a result of some experience and on a priori grounds we have a right to expect that the autocatalytic formula* will be more frequently followed in growth than the arithmetic or the simple geometric laws. Friedenthal (1914, p. 54), however, finds that, except at the very beginning, the human curve of growth resembles closely a parabola.

An analysis of growth in a number of higher animals, made by Robertson (1923) leads him, indeed, to the conclusion that growth in man, cow, rat, fowl and frog takes place in a number of cycles. In mammals the number is placed at three. Since in each cycle there is a marked change in the rate of growth, the development may be said in such

* This formula is as follows: $\log \frac{x}{A-x} = K\,(t-t_1)$ where A is the dimension (or weight) of the finished product of growth, K is a constant called the velocity constant or rate of growth, x is the growth accomplished at the expiration of any time t; and t_1 is the time when the reaction is half completed when $x = \frac{1}{2}A$. (Robertson, 1908, p. 585.)

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cases to be discontinuous. The animal may be said to undergo a metamorphosis in development.

The application of the word "metamorphosis" to human development has been criticized. Yet metamorphosis means merely rapid change of form as opposed to uniformly progressive increase of all parts, following one law. Metamorphosis is wide spread in development. All organisms that have a "larval form" undergo a metamorphosis into the adult. Such larval forms are seen in the polyp form of hydromedusae, the disconula form of Siphonophores, and ephyra of other jelly fishes, the medusa-like stage of some ctenophores, the Müllerian larvae of flatworms, the pelidium form of nemertines, the trochophores of annelids, the tonaria of Balanoglossus, the numerous larval forms of echinoderms, the nauplei and other larval forms of crustacea (especially Cirripedia), the trilobite stage of Limulus, the nymph stage of the lower insects and the grub or caterpillar stage of the higher insects (strikingly of

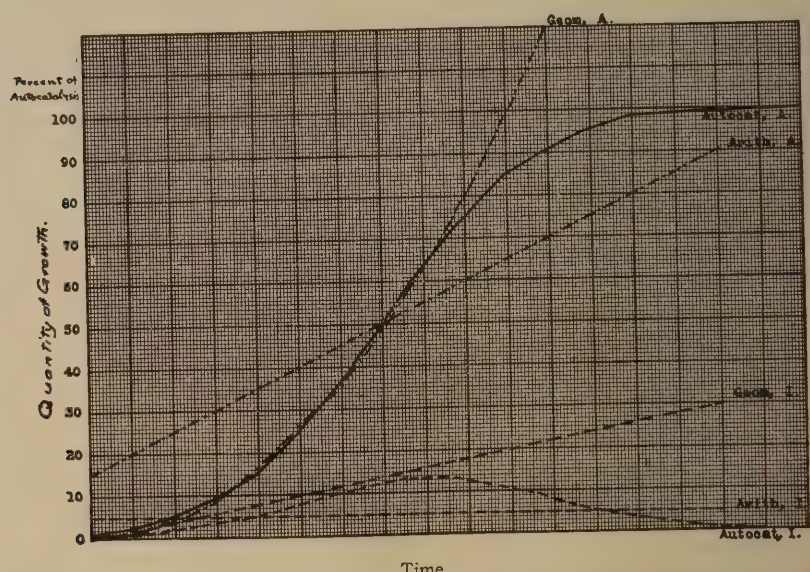

FIG. 1. Theoretical types of curves of absolute growth (A) and of increments (I). Arith. A is the line of arithmetical growth, with uniform and constant increments (Arith. I). Geom. A is the curve of growth gained by plotting the ordinates $y = e^x$. The increments are uniformly increasing as shown at Geom. I. Autocat. A is the autocatylic curve of growth in which $\log \frac{y}{a-y} = K\ (t-t')$. $a = 100\%$; t^1, is the time when $y = 50\%$, and is the zero point from which abscissal values are measured. $K = K_1a$, where K_1 = the velocity constant. The curve of corresponding increments is shown at Autocat. I, of which the formula is $y = e^{-x^2}$.

Lepidoptera); the veliger and other larval forms of mollusca, the cyphonautes and other larval forms of Bryozoa, the free swimming form of brachiopods, the tadpole-like larvae of tunicates, the amphioxus-like young of Petromyzon, the larval forms of many fishes (e. g. Accipenser, eel), the axolotyl form of urodeles and the tadpole of frogs; the chick stage of birds with rectrices but no contour feathers, the short-tailed, hairless young of mammals. Probably if all forms were studied carefully enough, differences would be found in the rate of development of different parts; and some parts would develop to function only temporarily, or for special purposes, like the so-called sucking pads of the human infant. The data set forth in this paper seem to support the view that man undergoes a very considerable, hitherto insufficiently studied, metamorphosis. That a metamorphosis occurs at the birth period is obvious; at this time fundamental changes of medium, of method of respiration and of feeding occur and, with them, marked bodily changes. But during later development a profound change occurs in the rate of development and in proportions of parts at puberty.

MATERIAL AND METHOD

For this study there were required data on the development not only of stature and weight, but also of the segments of stature and the proportions of as many of the parts of the human body as possible.

For statures and weights of all ages there are numerous mass collections, mostly averages of miscellaneous children of one locality and of different ages. There are a very few series of measurements reported on the same individual children from birth to maturity. The outstanding records of this sort are afforded by the work of Camerer (1901, p. 414–30), of v. Lange (1903, p. 291–294; 297–299; 302) and of Guttmann (1915, p. 254–56). Baldwin (1921, pp. 44, 47, 67, 70, 74–77, 84–87, 96–99, 108–9, 115–60) also has height and weight curves of a few individual boys and girls. At the Eugenics Record Office are, in manuscript, monthly measurements by Prof. Henry P. Bowditch of members of his family over a long term of years. We have also made use of the height and weight data taken at the Horace Mann School, New York City, on individual boys and girls in successive years. Our height and weight curves are, chiefly, compiled from the mass collections. These have been checked with the consecutive or successive individual measurements.

The measurements, other than height and weight, recorded in this paper, have been, for the most part, made on a collection of boys and girls of all ages from 3 to 17, inmates of the Orphan Asylum of Brook-

lyn. A word about the physical quality of these children. It has been shown by Hrdlička ('99), a generation ago, that orphan asylum children constitute a group that is distinctly below the average of normal children in physical development. We have, therefore, carefully compared the curves of height and weight of these children with the standards of school children of Worcester and of Iowa and find that the girls are slightly in excess in stature and weight of the standard girls and the boys are nearly at the standard, or at most 1 per cent below—a hardly significant difference. The children of this Asylum are, indeed, with few exceptions not waifs or foundlings or born of short-lived parents but some of them are placed in the asylum because the mother is chronically ill in a hospital so that the home is broken up; or father and mother have separated or become divorced; or other circumstances common in a great city have made it necessary to find an institutional home (often quite temporary) for one or more children in the family. The racial stock of this Asylum is remarkably uniform. Since it receives white Protestant children English surnames predominate; there are a number of Scotch, German and Scandinavian, a few North Irish and perhaps 2 per cent Italian; but most Catholic orphans and those of Jewish faith are placed in institutions provided by those segregates (denominations). The population of the Asylum is, thus, predominantly "Nordic."

The measurements were made by the author, in the case of the boys, and by his competent, well-trained assistants (Misses Grace Allen and Anna W. March) in the case of the older girls. As the three had measured repeatedly together, even the same person, it is quite certain that their measurements are comparable. The instruments used were chiefly those of Hermann of Zürich, based on designs of Dr. R. Martin, namely the anthropometer, sliding calipers and compass calipers. Enameled cloth tapes were used in place of steel as being easier to read and softer to the skin. They were discarded as soon as they showed wear or elongation; and were repeatedly checked on a steel tape.

The points plotted are based always on more than one measurement; usually on 8 to 15 up to 20 or more. The curve is drawn, usually, to the middle positions lying between the two points determined for successive years and its position thus depends usually on the average of 10 to 40 measurements. A greater amount of "smoothing" was permitted in a few cases; but it was realized that the smoothing process tends to conceal essential facts.

An appropriate question is the significance and reliability of the irregularities of the various developmental curves. For stature, weight,

span, sitting height and chest girth we had so many data that the end result must be considered significant. The more detailed measurements are available for fewer persons; rarely we had consecutive measurements made on the same children. No doubt remains that at the ends these curves will be somewhat changed when larger numbers are available. To avoid expense all of the full tables from which the curves are derived are not published; they can be obtained, where required for critical study, by sending to the Eugenics Record Office.

RESULTS

Stature. Figure 2 is a curve of development of vertex height from conception to maturity. It is based on a series of average lengths of fetuses as published by von Lange (1903); upon monthly measures from

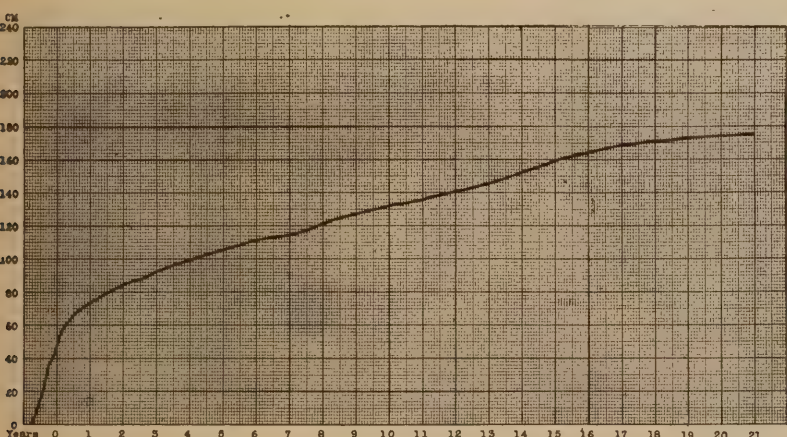

FIG. 2. Average development of Stature, conception to maturity, males, Northern European stock. Antenatal part of curve from E. von Lange (1903); from birth to 6 years, Woodbury (1921); 6 to 18 years, Boas (1897); 18 to 21 years, Beyer (1892). The slight irregularities at 2.5 and 7 years are possibly only statistical, due to insufficient numbers.

birth to 72 months compiled by Woodbury (1921) from 60,000 sets of measurements made under the direction of the Children's Bureau in 1918 (Tables 1 and 2); 6 to 8 years, data of Boas (1891); 18 to 21 years, data of Beyer (1892).

This may serve as the fundamental curve of development of human male stature, as represented in arithmetic plotting paper. It has, in the most general way, a relation to the autocatalytic curve (Fig. 1)

which is at the beginning asymtotic to X, passes rapidly upward to an inflection point at about the 5th month of gestation and then tails off in the course of 16 years more to become asymtotic to X at the upper level. It is obvious that this is not a simple autocatalytic curve, inasmuch as it does not meet the condition that the point of inflection is halfway between the beginning and end of the curve. Robertson (1908, page 587), who has discussed the qualities of this curve, or rather the curve of weight which parallels it roughly, as we shall see, concludes that there are two or more autocatalytic processes which go to make up

TABLE 1. DATA FOR FIGURE 2.

Age (mos.) from concept.	Stature, Males mm.
(E. V. Lange, 1903)	
0–14/15	06
1–13/15	28
2–12/15	78
3–11/15	140
4–10/15	223
5– 9/15	312
6– 8/15	366
7– 7/15	403
8– 6/15	439
9– 5/15	495
(Woodbury, 1921, p. 86)	
mos. from birth	
0–1	537
1–2	571
2–3	599
3–4	623
4–5	644
5–6	662
6–7	678
7–8	691
8–9	701
9–10	712
10–11	723
11–12	734
18	794
24	844
30	888

TABLE 2
DATA FOR FIGURES 2 AND 3.

Age	Stature, Males mm.	Stature, Females mm.
(Woodbury, 1921, p. 86)		
36	927	912
42	961	951
48	996	980
54	1022	1014
60	1054	1044
66	1082	1074
72	1114	1105
(Boas, Toronto children)		
years		
7	1168	1161
8	1221	1212
9	1269	1261
10	1318	1313
11	1362	1366
12	1407	1425
13	1460	1487
14	1524	1535
15	1597	1565
16	1649	1580
17	1689	1591
18	1711	1600
(Beyer, 1895)		
19	1725	
20	1740	
21	1742	

the total growth of an individual. In fact, "there are three maxima of rate of growth in the curve of growth for man, representing three phases or cycles." Robertson concludes, moreover, (p. 594) that one of these cycles is intrauterine, another reaches its inflection point at about the sixth year (5.5 years from birth), and the maximum in yearly increments "occurs in males at about the sixteenth year, that is, in the neighborhood of puberty"—inflection point at about 16.5 years from birth (p. 595). The curve of figure 2, for males, does indeed show not only

the intrauterine inflection point but also one at about 14 years; but there is no clear inflection point between birth and 14 years.

To test Robertson's conclusion, and indeed, for a further study of the curve of stature growth it becomes necessary to study the curve of annual increments of growth. For this purpose, there was calculated and recorded in Table 1, from the available data of Nordic peoples (in part taken from Baldwin, '21) the increment of stature, year by year, from birth to maturity and the results were averaged, different weights being assigned to the different series, roughly in accordance with the square root of numbers involved and also with attention to accuracy

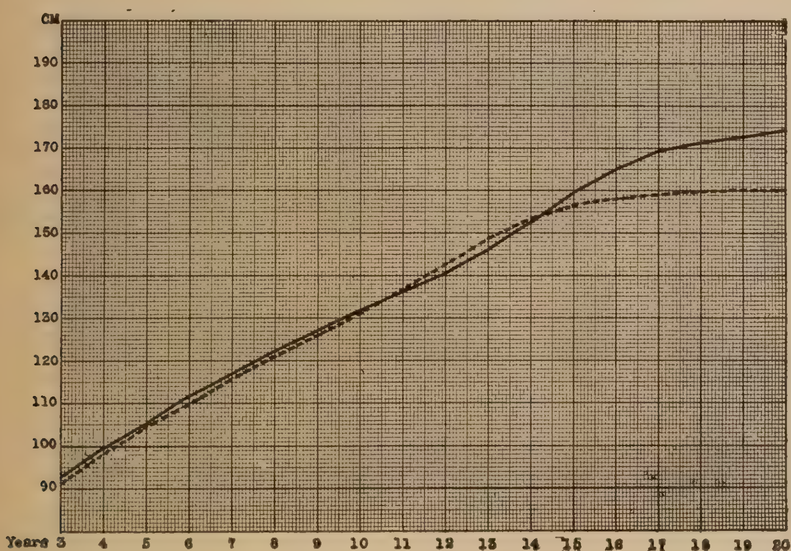

FIG. 3. Comparison of average development of stature in males and females. Male curve based on Fig. 2. Female curve: 3 to 6 years from Woodbury (1921); 5 to 18 years from Boas, Toronto children; 18 to 20 years, estimated.

paid in collecting the data. The averages of the weighted means of the measurements massed at the central points of the successive years of age were then calculated and plotted in Fig. 4 for both sexes. One notes the steady decline in increments of stature-growth from the first to the fifth year. Then there is a rise in the 6th year in both sexes, followed by a decrease to the 9th and 10th years with female and the 11th year in the male; followed in turn, by a rise to the well-marked maximum of adolescence.

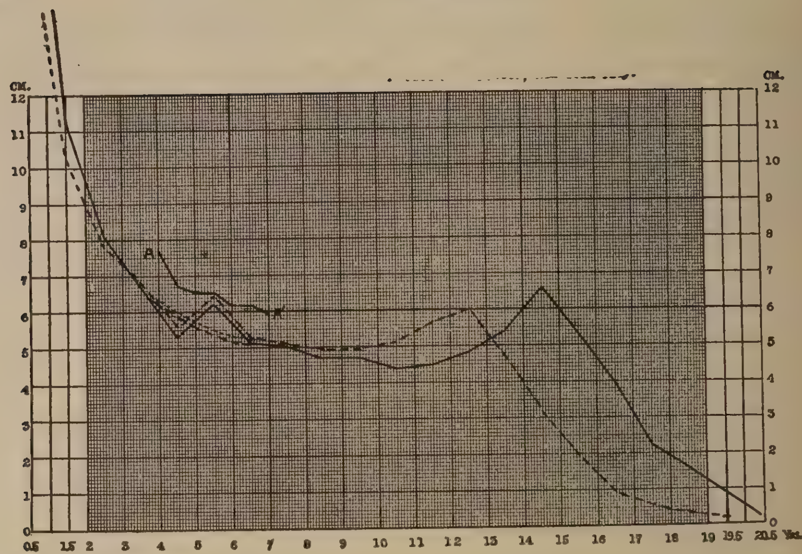

FIG. 4. Comparison of average annual increments of stature, males and females. Data derived from Table 3. Accessory curve, A–A′ is based on consecutive measurements of 64 boys at Horace Mann School, New York City; also five others. Table 4.

The peak at the sixth year now requires consideration. Is this Robertson's juvenile maximum of growth? It clearly is, since it coincides in time (to within a year or so) with his second growth cycle. The source of his data Robertson (1908, p. 594) gives as follows:

"The second growth-cycle, that is, the first extra-uterine growth cycle apparently attains its maximum annual increment at about the fifth year, for in the British Association Anthropometric Committee's (1879, p. 175) determinations of the average weight at various ages the increment in weight in the fifth year considerably exceeds the yearly increment for the years immediately following." In passing it may be added that this is an unfortunately weak criterion, since the yearly increments are generally declining from birth to the ninth year. It would have been more to the point to say that the increment in the fifth year considerably exceeded the yearly increments for the years immediately preceding but, unfortunately, there are no preceding years in the British Association Report. Robertson continues: "In Quetelet's observations upon Belgian Males and Females in each case the increments in the fifth and sixth years are equal and exceed the yearly increments in the years immediately following and preceding them. The time of maximum yearly increment during this growth cycle may there-

fore be set down at 5.5 years (from birth)." As the "British Association's Report, 1879" is not accessible to me, I take the Table of Weights that Robertson copies (on page 597) from the "Report." The developmental series begins with age.

4.5,	21 individuals	average	18.6 kg.				
5.5,	176 "	"	22.7	"	increment	4.1	kg.
6.5,	327 "	"	24.6	"	"	1.9	"
7.5,	631 "	"	25.9	"	"	1.3	"
8.5,	1038 "	"	27.0	"	"	1.1	"

It is difficult to see here any evidence for a growth cycle at 5.5 years, as the increments are, of course, falling generally, with the closing of the infantile (uterine) cycle. In Quetelet's (1871, p. 344) series, we find:—

Age in years,	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5
Obs. weight in kg.,	3.1	9.0	11.0	12.5	14.0	15.9	17.8	19.9	21.6
Increment over preceding year		5.9	2.0	1.5	1.5	1.9	1.9	2.1	1.7

The increment from 9.5 to 10.5 years is 17. The annual increments then begin to rise again.

It does not seem that one is justified in basing a third growth cycle on the British series which gives no data between birth and climax of the 5 year growth cycle; and on Quetelet's figures which are apparently means of only 10 selected individuals at each age and smoothed at that (Quetelet, 1871, pp. 174, 175).

Our Figure 4 is based on measurements of over 2,000,000 children (Table A*) without selection or smoothing of results. And it shows a maximum about where Robertson had located it, though in his case with wholly insufficient data.

There are certain features of the secondary maximum of Fig. 4 that arrest attention—principally that it affects only the sixth year; there is no premonition of it in the fifth year, nor after-effect in the seventh. It looks like a statistical, rather than a biological phenomenon. If, to get some light on a possible statistical basis for the irregularity, we examine Table 3 we find that in 7 out of the 14 series contributing data to the sixth year we have a first term of the series at that year. This means a serious break in continuity of the series of means. The reason for the break is apparently that 6 years is the first of the school years. Most of the measurements have been made on school children. Not all

*Appendix

children go to school in their sixth year. Those who go may well be selected for a development that is above the average. Probably this is why the first term in the Baldwin 1a series is twice as big for the 6th year as for the 7th and in Galton's series is 50 per cent bigger than in the 7th year. The extraordinary increment in the sixth year in Schmid-Monnard's series is possibly due to the same cause, although it is not the first term of the series, which includes nursery and kindergarten children, but probably not very large numbers of such.

TABLE 3.

Average Annual Increments in Stature (in cm.) of a Number of Boys at Horace Mann School, Measured Consecutively

Age, yrs.	4	4.5	5	5.5	6	6.5	7
Frequency	8	9	22	27	36	25	21
Mean annual increment	7.7	6.8	6.6	6.6	6.3	6.2	6.0

The foregoing considerations lead us to frame the hypothesis that the maximum at the 6th year in the curve of Fig. 4 is due to a selection consequent on the methods employed in gathering the statistics. The test of the hypothesis would be the comparison of the increments in successive years of individual children, measured repeatedly. Data for such a test are afforded by the consecutive measurements made at the Horace Mann School, New York City, and these measurements we have, through the courtesy of Dr. Thomas D. Wood, been able to use. The increments are given in Table 3, grouped into half year periods but calculated on a whole year basis. The averages of these continued series are given at the bottom of the Table from 4 to 7 years, covering the age period in question. The number of measurements for any year varies from 17 to 61. The series shows a uniform decline from 7.7 cm. at the 4th year to 5.4 in the early half of the 8th year. There is here no evidence of any important secondary maximum at the 6th year, and we may conclude that its occurrence in Fig. 4 is chiefly statistical and little if at all biological. The absolute positions of the averages of Table 3 are plotted on Fig. 4. Since the children are a selected lot their curve lies above that of average children. The probable position of the biological curve of growth in stature at the period from 4 to 6.5 years is drawn in Figure 4 as a heavy broken line.

The comparison of the method of growth in stature of the sexes shows much of interest (Fig. 3, cf. Table 2). From birth to 10 years the sexes run a parallel course and very close together, boys being a trifle heavier than girls. The very closeness and parallelism of the curves is a beautiful demonstration of the conclusion that the internal growth forces are the same in nature and nearly the same in degree in the sexes up to

about 10 years of age. At about 10 years the growth increments in the male are at their lowest ebb for the preadolescent period, while the stature of females is beginning its preadolescent spurt. So the female passes the male during the eleventh year and becomes increasingly taller until during the thirteenth year when the male adolescent spurt is setting in strongly, while that of the female has begun to decline. In the fifteenth year, the peak year of male growth, the boy passes the girl in stature and continues until in the adult there is a difference of 13 centimeters or more between the stature of the two sexes.

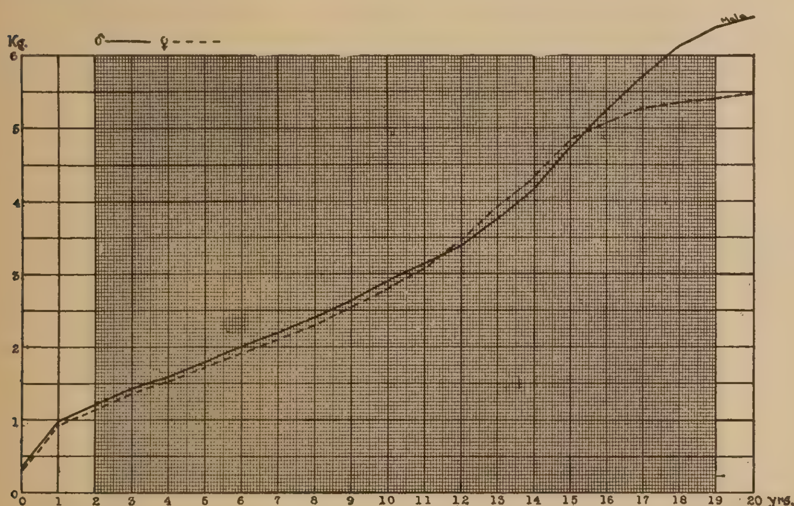

FIG. 5. Comparison of development of average body weight for males and females. Based on summary of Table 5.

Weight. The changes in average weight from birth to maturity for the two sexes are shown in Figures 5 and 6, based on Tables B and C, D and E*. During the first year of life, the slope of the weight curve begins to flatten out and in the male first makes an upward turn again at about 7 years. At 12 years the adolescent spurt begins to show. The female developmental curve of weight runs close to, though slightly below, that of the male. The parallelism is striking. In the 12th year, however, the adolescent spurt of the average girl brings her weight above that of the average boy and there it stays until the adolescent impulse has begun to fade away in the girl and to start in vigorously in the boy. At about 15 years the average boy passes definitely the aver-

*See Appendix.

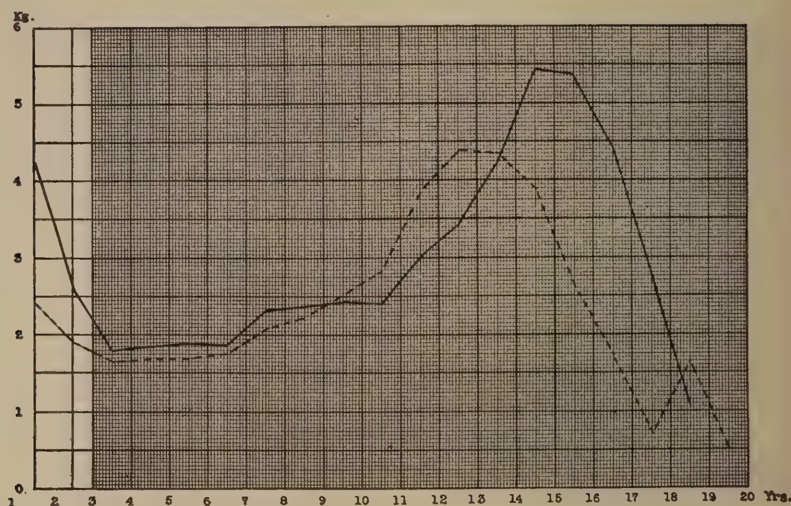

Fig. 6. Comparison of annual increments of body weight from the second to 20th year of age, male and female. Based on summary of all annual groups, Tables 7 and 8.

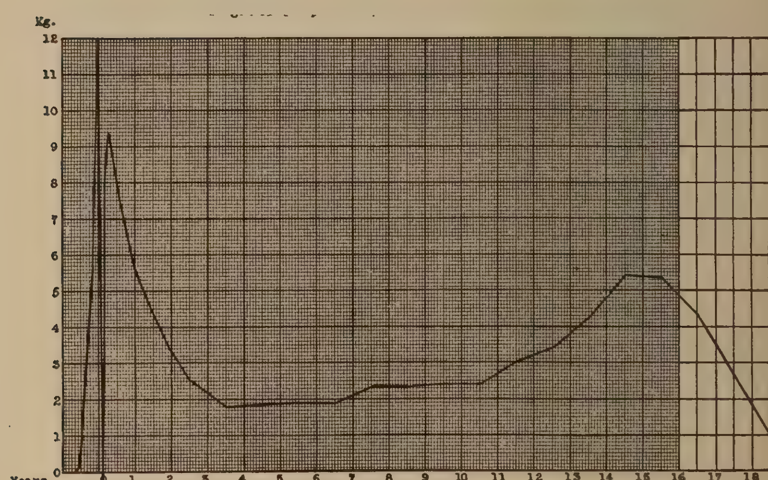

Fig. 7. Annual increments of body weight in males. Based on Zangemeister for prenatal section and Summary Table 7.

age girl in weight. It is due to the fact that in the boy the weight mode lags behind the height mode, that decussation of the weight curves occurs later than that of height.

The curve of increments of weight from conception to maturity is a striking one (Fig. 7). Three features are outstanding; the high mode at just before birth, when increments of weight per month are greater than at any other time; (2) the adolescent increment which finds its mode around 15 years; (3) the absence of any mode in the sixth year; (4) the brief period (of a few days) of negative increments directly following birth when the hitherto submerged organism becomes an aerial one. The rebound to nearly the prenatal rate of increase in weight directly following this depression is also of great physiological interest. The episode of depressed growth leaves no permanent impress. The rate of growth is not seriously affected by the temporary starvation.

Span. This is the distance between the tips of the fingers of the outstretched arms. It measures roughly the sum of both arms and the shoulder breadth.

In the determination of this dimension much depends on the method employed. I have usually called upon an assistant to hold the middle finger of one hand at the corner of the room, while I manipulated the movable arm of the horizontally placed anthropometer and directed the subject to see if he could reach that arm while I moved it away; ordering, meanwhile, to "stretch!" This was kept up until no increase of voluntary stretching power was observed. The movable finger was never pulled or seized; but sometimes guided to the movable arm of the anthropometer. The ability to stretch to the utmost was largely determined by the muscular tone of the individual. Sometimes, while being measured, he would suddenly add 2 or 3 centimeters to his span. A difference in method of measuring span makes the results of different authors not always comparable. Ernst (1906, p. 45) states: "Um die Kinder dazu bringen, dass Massordentlich auszuführen (sie mussten mehr oder weniger selbst tätig sein, indem sie mit dem ausgestreckten Mittelfinger der einen Hand das Schiebeblättchen des Anthropometers züruckdrückten) spernte ich sie fortwährend an gar recht zu strecken und reizte ihren Ehrgeiz gross zu erscheinen. Einige Knaben erzielten dann auch eine merkwürdig hohe Spannweite." Zeising (1858 test, Baldwin, '21, p. 401), seems to have used extraordinary means of increasing span, as the measures he obtained are relatively much higher than the findings of others.

The findings as to span of Ernst, Weissenberg and myself for boys and girls at different ages are given in Tables F and G. See the Appendix. The tables show that absolute span increases regularly from 3 years to 18 or over (Fig. 8). At an early age (4 years) it is greater in boys than girls, but at about 9 years of age in my series, and at 10 years in Ernst's (1906), the span of the girls exceeds those of the boys on the average. In the 15th year the growth of the girl's span is damping off while that of the boy is still in rapid development; so the boy's span comes to exceed the girl's again. In Weissenberg's Russian Jew children the decussations take place in the 8th and 14th years respectively. It is noteworthy that decussations of the sex curves of absolute span occur at about the same ages as the decussations of stature; revealing how intimately the two dimensions are associated.

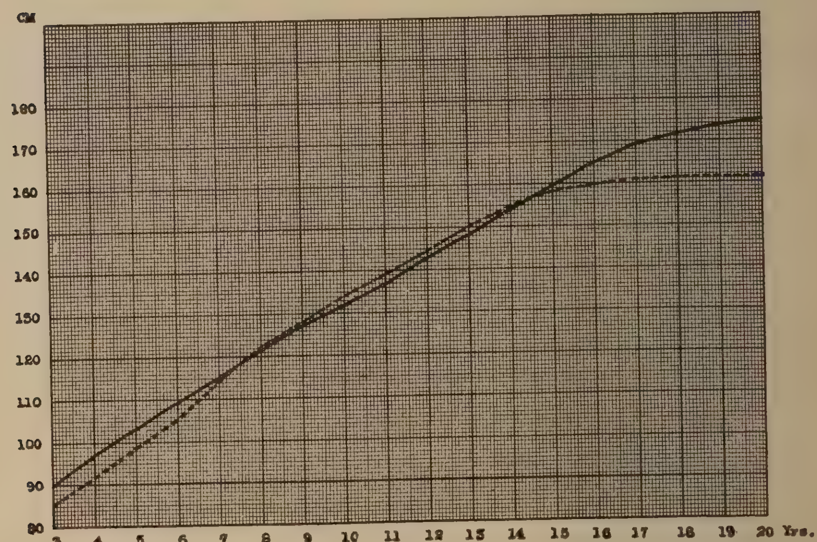

FIG. 8. Development of absolute span in normal males and females. Based on original Eugenics Record Office material, chiefly Brooklyn Orphan Asylum and Elmira College.

In Hrdlička's (1899) asylum children (of low grade) the girls come to exceed the boys in span only at 13 to 15 years; while in MacDonald's series the girls never passed the boys in span at any age.

Relative span changes in about the 8th year in the boy (Fig. 9) and the 7th in the girl (Fig. 10) from less than stature to greater than stature.

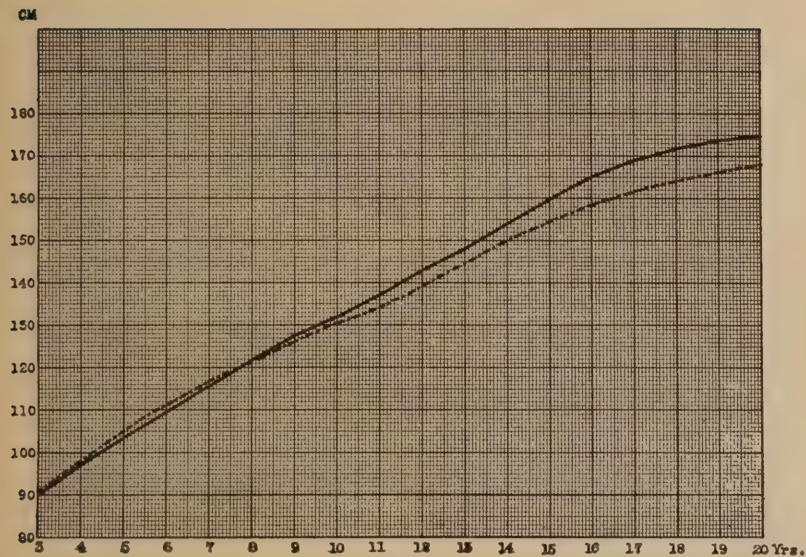

FIG. 9. Development of relation between stature and span in males; chiefly Brooklyn Orphan Asylum

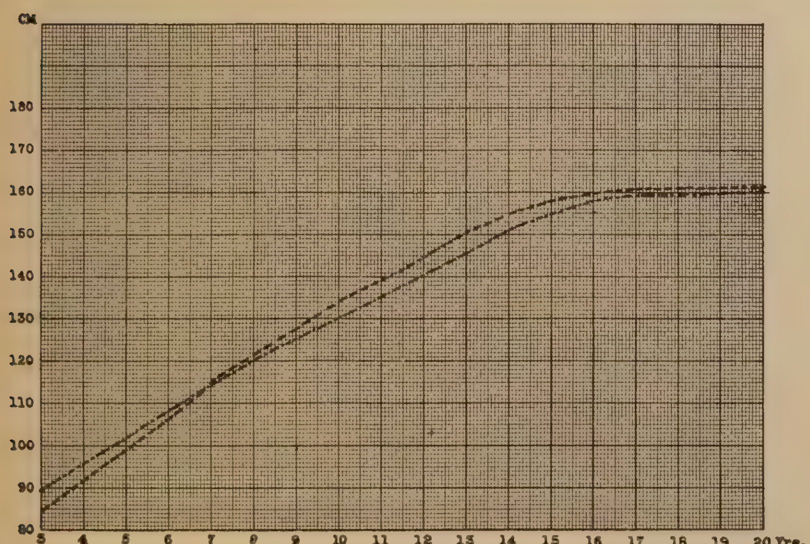

FIG. 10. Development of relation between stature and span in females; chiefly Brooklyn Orphan Asylum and Elmira College.

In the boy of 16 span is about 1.5 per cent greater than stature; in the girl of 16 about 0.8 per cent greater. In Zürich children (of shorter stature than the American) Ernst finds that span is already greater than stature in girls of 8 years and there is a somewhat larger ratio than ours at 14 years in both sexes.

Sitting Height and Leg Length. Stature, or vertex height, is a complex of more elementary dimensions. The chief two are sitting height and leg length. The sitting height measures the distance from the gluteal fold to the vertex. The leg length (in our statistics) measures the distance from the symphysion (pubic arch) to the sole of the feet. The symphysion is chosen rather than gluteal fold as the upper limit of leg length because it accords most nearly with the height of the center of the aceptabulum which is the upper limit of the true leg.

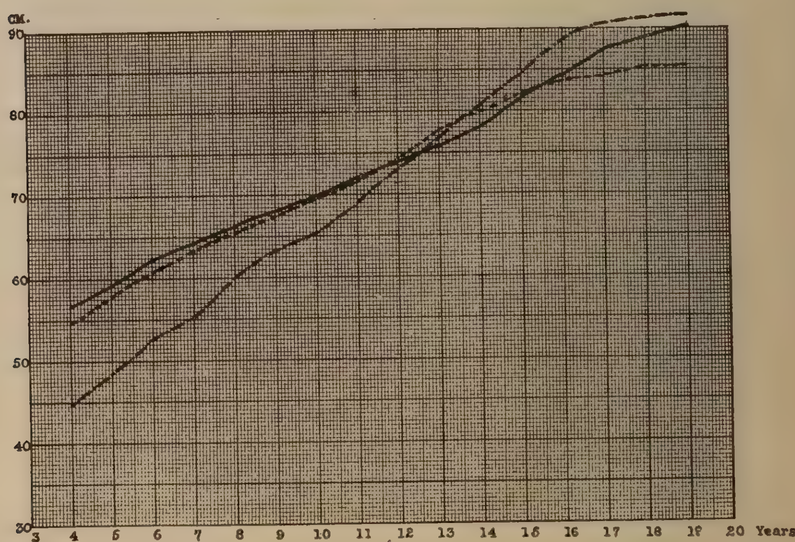

FIG. 11. Development of absolute sitting height, normal males and females; also length leg of males, Brooklyn Orphan Asylum series.

The curve of absolute sitting height for different ages and for both sexes (as given by our asylum data) is shown in Fig. 11. It appears that from 4 to 11 years of age sitting height of the female is much less than that of the male. It crosses the male curve in the 12th year and, thereafter, the trunk and head grow much faster than in the male, until at 13 years the increments begin to diminish while those of the male increase. The second decussation takes place in the 16th year.

The relative growth of legs and the upper part of the body (sitting height) is also brought out in Fig. 11, where the leg length is plotted for the male. Beginning, at 4 years, 13 centimeters shorter than the sitting height, leg length (of the male) advances much more rapidly than sitting height; catches up with sitting height at 12.5 years and comes to exceed it by about 3 centimeters at 15 to 17 years. Thus the legs grow independently of trunk in the child in the same way, though not to the same extent, as in the frog. By analogy we may conclude that there are special growth factors for the legs.

If sitting height be plotted in units of vertex height year by year, the resulting curve is a remarkable one (Fig. 12). From 3 to 12 years (in the male) there is a sharp decline dependent, of course, on the more

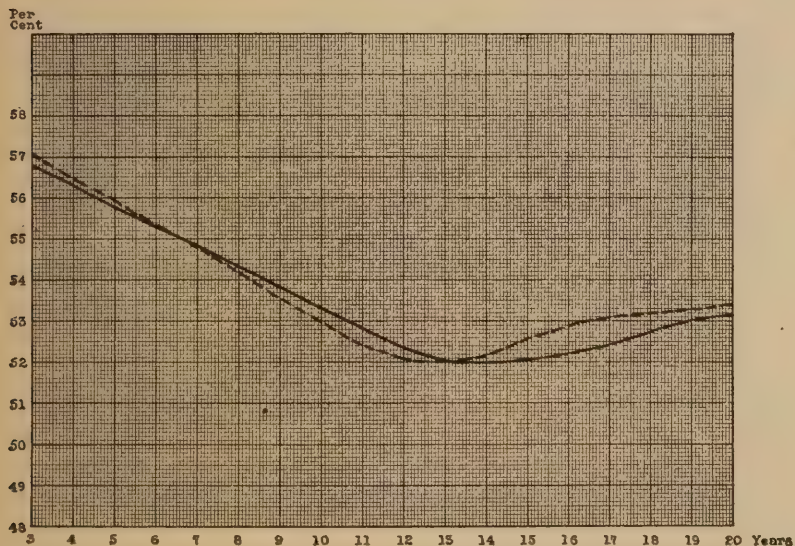

FIG. 12. Comparison of development of relative sitting height, normal males and females, Brooklyn Orphan Asylum series.

rapid growth of the legs than the trunk. Around the age of decussation of sitting height and leg length the curve flattens out and at about 14.5 years, in the male, begins to rise again. This is about the age when sitting height acquires a gradually increasing increment so that its ratio to leg length gradually increases also. A marked increase in the pelvic region (See Fig. 13, omphalion-symphysion and thigh length) at this time counts both on sitting height and leg length (which overlap in this region) and more than either on total stature.

Yearly Increments of Elements of Stature. While the curve of total annual increments of stature is fairly smooth, those of certain elements of stature—head and neck, suprasternal notch to thelion (nipples),

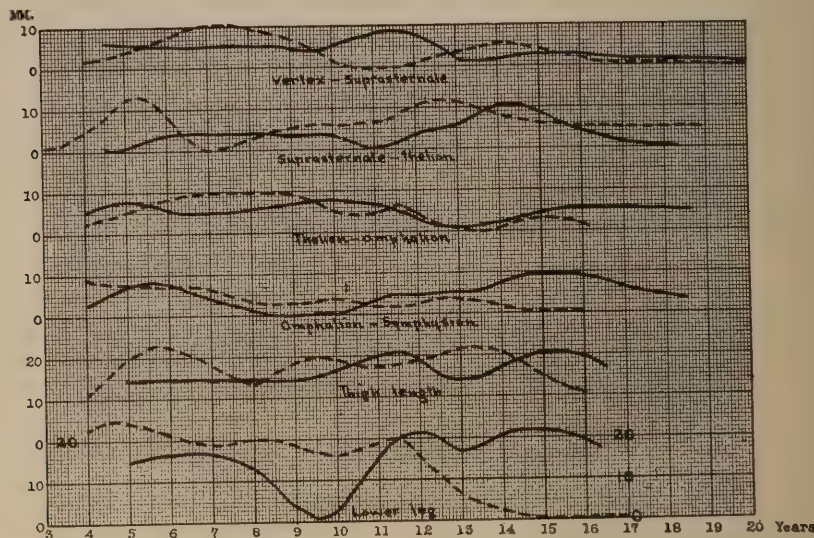

FIG. 13. Comparison of yearly increments of segments of stature, normal males and females, Brooklyn Orphan Asylum series.

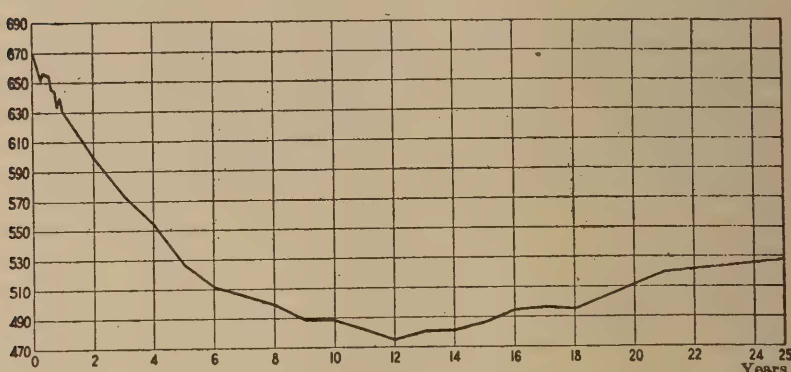

FIG. 14.—Polygon of development of relative chest-girth, male.

Abscissæ: Age in years. Ordinates (chest-girth ÷ stature) × 1000. Based on averages of the measurements of Quetelet (Belgians), Weissenberg (Russian Jews), Benedict and Talbot (U. S. A.), Masters Day Nursery, N. Y. City, Town (Iowa children), Gray and Jacobs (school boys, well-to-do), Reitz (Germans), Godin (French), Hitchcock (U. S. A. college men), Baldwin (N. Y. City Schools).

thelion to omphalion (navel), omphalion to symphysion, thigh length and lower leg—are very irregular (Fig. 13). They are shown only tentatively, and we do not know how much stress to lay on any of the irregularities, since they are massed measurements—not consecutive—and based on small numbers of persons, usually under 25 to each year. The summits to the right and some of those to the left are probably significant. Between 7 and 11 years there is relative uniformity of increments. An irregularity in elements of stature is not at all incompatible with marked smoothness in the summation of them all, such as is found in the increments of total stature.

Development of Relative Chest Girth. Finally may be mentioned the polygon of development of relative chest girth (male, Fig. 14). We see a quick descent from birth where chest girth is 66 per cent of stature to 12 years where it is only 48 per cent, followed by a slow rise to maturity where chest girth averages about 53 per cent. This irregularity, again, is largely produced by the great growth of the legs in childhood followed by a broadening of the chest in the post adolescent stage.

DISCUSSION

Human development is a complex process or, better, combination of processes. It does not follow any one of the simple laws of growth but combines them all. In the uterus, growth proceeds in practically geometric fashion up to the moment of birth. Indeed it is not too much to say that the relative precision with which parturition occurs after about 270 days of development in utero is due to this geometrical increase. For at that time a point is reached where every additional day adds its increasingly large increment to the embryo. Consequently every successive day that birth is postponed the demand for delivery is not only greater than on the preceding day, but the increment of this demand on the third day over the second is greater than the increment of the demand on the second day over the first. Again, in the adolescent period growth in stature or weight growth follows closely the autocatalytic formula and the curve of increments of growth is nearly a binomial curve, like Fig. 1, Autocat. I. Finally, there are prolonged periods when growth is practically arithmetic as in the stature of girls from 6 to 10 years, or in weight of boys from 3½ to 6½ years. During this period the curve of increments is practically a horizontal line.

In the entire span of growth in weight (Fig. 7) two great episodes stand out; that centering around birth and that centering about the onset of sexual maturity. These are episodes of great growth activity which closely resemble autocatalytic cycles. In the period between these

two, growth proceeds by regular, almost arithmetic, increments. As we contemplate Figure 7 it is brought home to us that in growth, from initiation to cessation at maturity, three elements are involved; (1) an underlying steady growth of the arithmetic type; (2) a tremendous acceleration of this basal growth by the intervention of special activators from fertilization of the egg in the period immediately following birth; (3) a lesser accelerator of this basal growth process by special activators that begin their work at 10 or 11 years after birth and reach a maximum of effect in the thirteenth year of the girl and the fifteenth of the boy.

It is quite clear that the circumnatal growth cycle and the adolescent growth cycle are due to quite different types of stimulant of the growth processes. There are different activators at work and they cause a differential growth of different organs. The fetal growth cycle affects particularly the increase of dimensions of the head, the length of trunk rather than its girth, the length of arm in relation to trunk or leg, the length of trunk rather than of legs (Schultz '23, p. 292–4). The adolescent growth cycle affects the increase in trunk length more than head height; the girth of trunk more than its length; the length of leg more than that of trunk; the length of leg more than length of arm (cf. Stratz, 1922, p. 62; also MSS. E. R. O., Asylum data). Now we know from experimental work on frogs that different endocrine glands play a different part in activating development; thus the thyroid is necessary to the rapid development of the legs that occurs during metamorphosis and the anterior pituitary in excess may delay the loss of tail. The gonads in man seem to repress growth of the legs in the male from the 17th year, as is shown by the fact that in eunuchs the legs apparently continue to grow until relatively longer than in the uncastrated male.

Due to the new activators that function differentially on new sets of organs at the onset of adolescence the curves of ratios of parts of the body do not constitute straight lines throughout development; but, on the contrary, have often a special and interesting form. This is well illustrated in the relation of sitting height to stature (Fig. 12). Here is shown how in both sexes from 3 to 12 years the sitting height diminishes in relation to total stature and especially leg length. Then at adolescence the trunk advances, relatively. The same thing is shown in chest girth in relation to stature. Horizontal trunk dimensions also are incited to rapid growth as adolescence sets in.

The meaning of the two epochs of accelerated growth—the fetal and the adolescent—has not been worked out experimentally in satisfactory fashion. Experimental studies by Dr. Swingle and myself (still in

MSS.) have shown that a modification of activity of the thyroid of the mother causes dwarfish young to be born (possibly of the mongoloid dwarf type) and the milk secretions of such mothers do not accelerate growth normally. One cause of the extraordinary growth of the fetus and young infants must be particular growth-inciting hormones that come to the young through the placenta before birth and through the milk after birth. Nothing that the developing individual gets subsequently quite equals in potency such gifts from the mother.

A second growth-promoting factor in the circumnatal period is clearly the secretions of the individual's own thyroid. The evidence for this is found in cretins, who are born dwarfish and develop slowly, but may be made to assume the normal rate of growth by the ingestion of iodine or thyroxine containing the active principle of the thyroid gland.

Possibly there are other special accelerators of the normal growth process of the circumnatal period; but they are unknown.

The nature of the special activators of growth in the adolescent cycle is partly known. Thus if tethelin (extracted from the anterior lobe of the pituitary) be administered to a mouse in the preadolescent period (5th to 13th week) it tends to become, on the average, about 25 per cent larger than the control; while some mice show an increase of 50 per cent. Since a week in the life of a mouse is about equal to a year in the life of a man this substance exerts its effect during the equivalent of the period of from 7 to 12 or 14 years when preadolescent growth increments show in man. It seems probable that the anterior pituitary is largely responsible for this growth cycle. And, apparently, the growth of the head-and-neck and upper third of trunk are more especially affected than the leg. There are not only growth cycles but in them the same organs are not involved to the same degree. This is the physical basis of the metamorphosis in man as in the frog.

As between the sexes, the developmental curves shown here run quite a similar course, except that the adolescent cycle starts in and culminates about two years earlier in girls than in boys. This leads to a double cutting of the developmental curves, since the girl is at first below the boy; surpasses him during her precocious adolescent cycle and then falls behind him as her maturity sets in, just as his adolescent spurt gains strength. This would seem to suggest that the pituitary (or other special growth activators of this period) gains its functional activity earlier in the female than the male. This results in earlier maturity; shorter stature and relatively shorter legs in the female than in the male.

CONCLUSION

The conclusion of the whole matter is that the body does not "grow as a whole" as Castle (1922, p. 19) maintains, but growth of the body is the resultant of several growth-promoting internal stimuli. These act at different times and upon different organs and this is the essence of metamorphosis.

In different races the relative activity of these stimuli is diverse, so that some races are long-legged, like the Nilotic negroes and Australian aborigines; others short-legged, like the southern Chinese; some are slender, like the Scotch Highlanders; others fleshy or chunky, like many of the Balkan people. Clearly in the different growth inciting and regulating factors there are hereditary differences. All races of mankind do not undergo precisely the same degree or kind of metamorphosis.

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Basal Tables of Stature and Weight

Table A. Annual Increment Rate (in cm.) in Stature (Height). Males.

References		Values	0–1	1–2	2–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	10–11	11–12	12–13	13–14	14–15	15–16	16–17	17–18	18–19	19–20	20–21
Baldwin, 1921, p. 261, cal. 1b		2							46	71	33	45	33	61	49	48	91	31	20				
" 1a		2						131	65	39	48	58	43	46	27	71	68	50	46				
" 2a		3						45	60	55	42	51	45	36	63	62	57	72	3	39			
" 2b		3								51	45	41	55	43	55	61	88	31	42	29			
Barnes	Baldwin 3	2							23	66	43	66	41	41	43	73	54	68	66	13			
Boas	" 6	2							43	68	35	51	45	47	56	74	76	36					
Bowditch	" 9	3						55	51	51	49	51	42	45	53	68	63	67	30	12			
Hall	" 17	1										68	31	40	109	33	77	30	15	5	6	2	3
Hastings	" 20	2						49	50	56	45	51	40	53	38	70	71	55	63	11	7	4	
Peckham	" 25	3			109	82		46	51	50	49	47	49	31	64	61	60	72	39				
Porter	" 27	3							51	50	54	43	51	43	48	51	68	54	48				
Smedley	" 30	2							51	51	52	48	42	45	59	64	62	60	38	34	43		
Stiles & Wheeler	" 33b	1							69	37	42	52	38	58	59	38	72						
West	" 34	1						31	43	52	47	70	48	41	47	67	80	36	25	15	13	28	–36
Boas	" 36	2						47	52	52	48	50	43	44	56	51							
Elderton	" 39b	1							46	53	54	48	43	41	43	46							
Galton	" 41	1						77	50	26	68	54	43	38	51	58	74	53	49	17	10	6	2
Roberts	" 44a	1	190	170	79	42	65	76	50	27	67	55	42	38	49	61	74	78	33	13	7	5	
Tuxford & Gregg	" 49a	4				58	48	50	67	46	54	47	48	56	27	46							
Key	" 52a	3							50	50	50	20	30	40	40	50	70	60	50	30	10	10	
Quetelet	" 55	1	199	91	74	63	61	59	58	57	56	55	52	50	48	46	45	41	40	36	25	13	
Godin	" 57	2															70	45	38				
Carstädt	" 61	1							45	51	48	48	48	48	52	58	75	62					
Rietz	" 73a	2							37	55	39	45	38	59	52	54	64	31	32	20	–4		
Schmid-Monnard	" 76	2	182	115	48	91	41	103	59	36	43	40	51	49	42	53							
Ernst	" 81	1										25	44	37	46	32							
Crum, 1915		2		107	86	60																	
Woodbury, 1921		5	212	105	78	65	59	68															
Schwerz, 1912		1								23	42	71	41	36	39	53	64	25	31	44	26	21	
Deutsche Aus-schuss, 1924, p. 56		5							53	50	49	46	42	43	48	56	58	54					
" (Camerer-Pirquet, Ger.), p. 65		1			80	60	50	50															
" (Sundell, Stockholm), p. 68		1									60	53	44	46	46	55	63						
" (Hertz, Kopenhagen), p. 68		2								35	46	44	43	60	54	27							
" (Schiötz, Volkssch. Oslo), p. 69		3									40	43	48	41	42	41	49						
" (Schiötz, Hohensch.), p. 69		2											33	38	38	33	55	62	65	42	30	14	6
Westergaard, 1920		2							35	47	44	51	51	43	39								
Martin '25 (Müncher Volkssch. Kinder)		2							45	52	48	22											
Weighted Sums			1813	1230	1218	1270	745	1931	2695	2937	2980	3047	2842	2921	3138	3429	3501	2539	1565	700	269	141	–19
Divisors			9	11	15	19	14	31	53	59	63	65	65	65	65	63	53	48	40	32	17	13	5
Weighted Averages			201	112	81	67	53	62	51	50	47	47	44	45	48	54	66	53	39	22	16	11	–4

TABLE B. ABSOLUTE WEIGHT IN TENTHS OF KILOGRAMS, MALES.

References		Value	Age, Years Birth	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Quetelet '71, p. 346		1	31	90	110	125	140	159	178	197	216	235	252	270	290	331	371	412	454	497	539	576	595	612
Camerer '01, p. 421		1	34	103	132	155	168	193																
Crum,	Baldwin, '21, p. 256	2		104	123	146	163																	
Woodbury '21, p. 85		5		97	121	140	156	172	189															
Freeman	Baldwin, '21, p. 253	1	36	99	131	169	186	206	217															
Schmid-Monnard	Baldwin, '21, 253, 303	2	34	86	111	132	147	161	184	215	215	235	257	278	305	336	380							
Schlesinger	Baldwin, p. 302, 75d	3							229	239	263	296	309	339	375	428	470	534	583	629	656	690	690	
Baldwin	Baldwin, p. 256	3		92	117	137	155	169	186															
Westergaard, 1920		2							204	216	235	256	281	306	333	363								
Deut. Zentr. Ausschuss	1925, p. 54	10								203	222	244	266	288	310	339	374	427	477	530				
Baldwin	Baldwin, '21, p. 294, 1a	2						173	195	213	246	274	304	333	367	406	431	476	539	583	585			
Baldwin	Baldwin, 1b	2							213	225	259	266	305	323	348	390	436	488	508	566	592			
Baldwin	Baldwin, 2a	3						190	205	230	253	276	309	337	350	401	447	494	543	566	616			
Baldwin	Baldwin, 2b	3								243	269	281	307	341	373	417	474	533	581	631	651			
Smedley	Baldwin, p. 297	2							197	216	238	263	287	312	342	381	427	480	533	574	613			
Godin	Baldwin, p. 300, 57	2.5															393	441	503	548				
Peckham	Baldwin, p. 297, 25	3						187	203	223	244	270	297	322	345	385	435	494	554	592	625			
Tuxford & Gregg	Baldwin, p. 300, col. 49a	4				149	163	175	193	212	229	251	274	299	331	352	382							
MacDonald	Baldwin, p. 297, 24a	2						205	217	234	255	279	300	330	360	401	458	516	550	599	600			
Stiles & Wheeler	Baldwin, p. 297, 33b	1							197	227	247	261	295	316	353	390	420	501	501	568				
Elderton	Baldwin, p. 298, 39b	1							196	211	232	255	278	301	321	349	377							
Galton	Baldwin, p. 298, 41	1						181	201	226	249	274	306	327	348	372	417	466	540	590	623	633	650	659
Barnes	Baldwin, p. 294, 3	2							216	228	246	270	303	327	353	406	440	490	552	597	615			
Boas	Baldwin, p. 294, 50	2							207	226	245	269	298	323	356	394	445	516	556	602				
Hall	Baldwin, p. 296, 17	2										265	300	325	365	407	452	493	570	607	629	638	647	658
Hastings	Baldwin, p. 296, 20	2						178	193	213	231	250	278	298	329	355	396	469	528	567	591	616	610	
Hasse	Baldwin, p. 301, 66b	1										252	271	294	324	350	373							
Hasse	Baldwin, p. 301, 66a	1										266	282	290	324	358	387							
Reitz	Baldwin, p. 302, 73a	1							225	243	260	277	320	343	404	430	500	511						
Reitz	Baldwin, p. 302, 73c	2										270	292	324	351	394	438	488	540					
Kotelmann	Baldwin, p. 301, 67	1										276	295	323	348	384	435	489						
Hertel	Baldwin, p. 300, 53a	3								217	232	250	272	297	322	350	385	435	497	552	583			
Key	Baldwin, p. 300, 52a	3							205	228	260	293	305	322	345	376	423	468	523	576	613	633	652	
Bowditch	Baldwin, p. 295, 11b	3										262	287	313	346	384	420	466						
West	Baldwin, p. 298, 34	1						193	209	224	243	271	302	322	357	391	445	509	561	603	604	647		
Porter	Baldwin, p. 297, 27	3							198	217	238	261	283	310	335	366	404	462	516	557				
Ernst, 1906, p. 49		1									240	250	263	286	311	343	370							
Schwerz, 1912, p. 9		1							195	205	219	241	276	296	313	339	385	429	454	500	553	597	645	
Weighted Sums			169	1442	1797	2712	3011	5564	10665	13140	14665	18663	20413	22145	24108	26622	29711	29180	29681	31126	22001	8930	8430	2587
Divisors			5	15	15	19	19	31	53	60	61	71	71	71	71	71	71.5	61.5	51.5	54.5	36	14	13	3

Table C. Absolute Weight in Tenths of Kilograms, Females.

References		Value	Birth	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
			Age, Years																					
Roberts	Baldwin, p. 313, c 44a	1	31			145	161	180	192	212	237	252	281	309	347	395	439	475	511	521	534	561	559	550
Peckham	B., p. 312, c 25	2						181	196	213	231	256	283	312	353	399	443	480	502	514	510			
Tuxford & Gregg	B., p. 254, c. 7a; B., p. 313, c. 49a	4				144	158	171	186	205	222	248	267	296	335	363	398							
Quetelet	B., p. 254, c. 9; B., p. 314, c. 55	1	30	86	110	124	139	153	167	178	190	210	230	255	290	325	363	400	435	468	498	521	523	
Camerer	(1901)	1	32	95	120	140	157	175																
Schmid-Monnard	B., p. 254, c. 14; B., p. 315, c 76	2	33	86	110	126	143	156	185	192	214	235	253	284	318	362	408							
Elderton	B., p. 313, c 39 b	1							190	207	224	246	267	292	320	357	404							
Galton	B., p. 313, c 41	1						178	189	216	236	252	281	308	347	396	439	481	513	522	549	562	560	552
Westergaard, 1920		2			109	128	148	163	177	197	216	236	259	280	311	350	400	457	504					
Deutsch. Zentral Ausschuss., (1924), p. 55		5								200	217	237	257	285	316	352	400	456	492					
MacDonald	B., p. 312, c 24 a	2						196	207	224	244	265	291	332	371	422	455	477	499	506				
Stiles & Wheeler	B., p. 312, c 33 b	1							204	223	239	264	290	323	382	434	448	494	508	524				
Barnes	B., p. 310, c 3	2							208	218	237	266	287	316	358	411	445	494	498	534	537			
Boas	B., p. 310, c 6	2							207	225	253	272	303	337	382	427	480	502	529	533				
Hastings	B., p. 311, c 20	2						173	185	207	221	248	271	289	330	379	428	466	503	503	501	513	522	
Woodbury	(1921,)p. 85	5		91	114	134	150	166	184															
Crum	B., p. 256, c 20	2		92	120	138	153																	
Baldwin, 1921, p. 310, 1b		2							198	219	233	264	297	303	342	430	465	508	495	514	525			
Baldwin, 1921, p. 310, 1a		2						172	189	218	248	261	294	325	376	416	464	500	515	535	531			
Baldwin, 1921, p. 310, 2a		3						172	193	213	244	268	300	332	381	445	491	515	540	547	542			
Baldwin, 1921, p. 310, 2b		3								227	237	265	302	338	386	445	491	527	561	568	566			
Smedley	B., p. 312, c 30	2							189	210	230	253	278	307	344	390	442	482	507	524	529			
E. R. O.		1				137	147	164	190	218	238	277	293	326	379	416	472	513	527	543	543	554	543	564
Freeman	B., p. 254, c 2	1	35	94	133	163	185	195	214															
Baldwin (1921), p. 256		3		91	111	131	146	164	181															
Ernst (1906), p. 54		1										241	273	308	319	357	401							
Schwerz (1912), p. 9		1							185	200	217	237	257	285	316	352	400	457	492					
Hasse	B., p. 315, col. 66a	1										258	278	306	346	384	423							
Reitz	B., p. 315, c 73b	1							196	216	233	246	275	302	343	392	430							
Reitz	B., p. 315, c 73c	2										269	300	333	374	418	464	505						
Key	B., p. 314, c 52a	3								213	233	260	281	306	339	378	422	469	502	531	555	568	576	
Bowditch	B., p. 310, c 11b	3										253	278	304	342	389	433	466	496					
West	B., p. 312, c 34	1						179	198	218	234	260	288	317	362	398	450	476	494	522	544	537	543	
Porter	B., p. 312, c 27	3							189	208	229	251	275	302	337	385	423	467	503	526	524	522	539	
Hasse	B., p. 315, col. 66b	1										248	270	296	328	364	401							
Weighted sums			194	1359	1944	3132	3497	5828	9160	10537	11504	14709	16176	17818	20072	22716	25230	22650	22850	17942	15495	7031	7117	1666
Divisors			6	15	17	23	23	34	48	50	50	58	58	58	58	58	58	47	45	34	29	13	13	3
Weighted averages			32	91	114	136	152	171	191	211	230	254	279	307	346	392	435	482	508	528	534	541	547	555

TABLE D. ANNUAL INCREMENT RATE IN WEIGHT, IN TENTHS OF KG. ♂, ANNUAL GROUPS.

Racial stocks	Numbers	References	Value	1–2	2–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	10–11	11–12–	12–13	13–14	14–15	15–16	16–17	17–18	18–19
Var. Nordic stocks		Schwerz, Tab. 10	20						19	28	24	22	24	30	34	44	51	54	43	31	23
Wisc. schools	10,000, clad	Peckham, 1881 Baldwin, col. 25	3		27	21	28	16	20	21	26	27	25	23	40	50	59	60	38	33	
All Engl. schools	375,000, clad	Tuxford & Gregg, '11	4			15	13	17	19	17	22	23	25	32	21	30					
Selected Belgians	10 of each age	Quetelet, '11	1								19	17	18	20	41	40					
German	26 consecut.	Camerer, '01	2	.69	29	23	14	25													
Halle, Ger., school ch.	Over 2500 clad	Schmidt-Mon. '01	2	25	21	15	19	23	14	17	20	22	21	27	31	44					
Washington, D. C. laboring cl.	7953 clad	MacDonald, '97	2					12	17	21	24	21	30	30	41	57	58	34	49	1	
Southern states, good condit.	593 clad	Stiles & Wheeler, '15	1						30	20	14	34	21	37	37	30	81	0	67		
Glasgow, better class	500–600 per yr., no shoes	Elderton, '14	1						15	21	23	23	23	20	28	28					
English, all classes		Galton, '83	1					20	25	23	25	32	21	21	24	45	49	74	50	33	10
English, all classes		Shuttleworth, '77	1								22	23	23	34	34	34	45	68	79	34	6
Nordic	7–18 per yr. nude	E. R. O.	1					31	13	12	38	13	18	38	33	14	58				
Denmark, schools	65–188 pr. yr.	Westergaard, 1920	1						12	18	22	25	25	27	29						
Oakland, schools	2500 clad	Barnes, '92	2						12	18	24	33	24	26	53	34	50	62	45	28	
Toronto, schools	2100 clad	Boas, '97	2						19	19	24	29	25	33	38	51	71	40	46		
Penn. schools	2434 clad	Hall, '95	2									35	25	40	42	45	41	77	37	22	
Nebraska, schools	2700 clad	Hastings, '00	2					15	20	18	19	28	20	31	26	41	73	59	39	24	
German (south)	6–8 consecutive	Guttmann, '15 and Camerer, '01	1	27	27	14	19	21	22	30	28	27	29	47	46	63	47	38	32	26	16
		Weighted sums		215	208	213	221	338	797	1001	1059	1143	1123	1415	1618	1948	2063	1984	1634	962	32
		Divisors		5	8	12	12	18	43	43	45	47	47	47	47	46	38	37	37	34	3
		Weighted averages		43	26	1775	1842	1875	1853	2328	2353	2432	2389	3010	3442	4235	5429	5362	4416	2829	10.7

TABLE E. ANNUAL INCREMENT RATE IN TENTHS OF KG., ♀, ANNUAL GROUPS.

Racial stocks	Numbers	References		Value	1–2	2–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	10–11	11–12	12–13	13–14	14–15	15–16	16–17	17–18	18–19	19–20
Zurich	25 each age	Ernst '06		1								6	58	11	11	66	23						
Schaffhausen	21–95 p.yr.	Schwerz '12		1						8	26	14	26	30	32	39	69	52	20				
Turin, rich		Pagliani	Bald., p. 316	1								23	22	12	33	58	54	26	1				
Gohlis-Leipzig		Hasse	Bald., p. 315	1								25	14	42	38	37	42						
Berlin, rich	2,500 ±	Reitz	Bald., p. 315	3						20	17	14	28	28	41	49	38						
Denmark, rich		Hertel	Bald., p. 314	3											30	45	50	30	45				
Sweden, rich	3,000	Key	Bald., p. 314	3						9	34	19	25	25	40	37	52	41	27	30	17		
Boston, rich	10,000	Bowditch	Bald., p. 310	3						17	22	28	22	31	44	47	40	37	16	18			
Worcester school	1,000	West	Bald., p. 312	1								27	28	29	44	36	52						
St. Louis school	15,000	Porter	Bald., p. 312	3						21	22	24	27	35	48	38	44	33	26	8			
English, all classes		Roberts	Bald., p. 313	1					12	20	25	15	29	28	38	48	44	36	36	10	13	27	−2
Wisc. schools	4,891 clad	Peckham, '81	Bald., p. 312	2					15	17	18	25	27	29	41	46	44	37	22	12	−4		
All Engl. schools	259,000 clad	Tuxford & Glegg, '11	Bald., p. 313	4					15	19	17	26	19	29	39	28	35						
Selected Belgians	10 per yr.	Quetelet, '71		1	24	14	15	14	14	11	12	20	20	25	35	35	38	37	35	33	30	23	11
Germans	10–18 con.	Camerer, '01		1	26	20	18	18															
Ger. (Halle) schools	1177, clad	Schmid-Monnard, '01		2	24	16	17	13	29	7	22	21	18	31	34	44	46						
Glasgow, better class	400–700 pr. yr., no shoes	Elderton, '14		1							17	17	22	21	25	28	37	47					
English, all classes	clad	Galton, '83	Bald., p. 313	1					11	27	20	16	29	27	39	49	43	42	32	9	27	13	−2
Denmark schools	150–600 pr. yr.	Westergaard, 1920		2		20	19	15	14	20	20	20	23	21	32	39	48	58	47				
Ger. schools, post-war	200,000 ±	Deut. Zentralaussch, '24		5						14	19	22	23	27	29	40	42	47	31	28			
Wash., D. C., laboring class	8520 clad	MacDonald, '97	Bald., p. 312	2					11	17	20	21	26	41	39	51	33	22	22	7			
Southern States, good con.	877 clad	Stiles & Wheeler, '15	Bald., p. 312	1						19	16	25	26	33	59	52	14	46	14	16			
Oakland Sch.	4956 clad	Barnes, '92 —	Bald., p. 310	2						10	19	29	21	29	42	53	34	49	4	36	3		
Toronto Sch.	2304 clad	Boas, '97		2						18	28	19	31	34	45	45	53	22	27	4			
Nebraska Sch.	7069 clad	Hastings, '00		2					12	22	14	27	23	18	41	49	49	38	37	0	−2	12	9
U. S. A., unsel.	Mostly over 20,000 pr. yr.	Woodbury, '21		5	24	20	17	16	18														
U.S.A., baby shows	400–2000 per yr.	Crum, '15		2	25	14	15																
U.S.A., well-to-do	ca 800 consec.	Baldwin, '21 (summed and weighted)		3					19	24	22	23	33	27	47	60	44	35	16	14	0		
Chicago, avg. sch.	total 3471	Smedley, '00		2						21	20	23	25	29	37	46	52	40	25	17	5		
Asylum & college	7-18 pr. yr. nude	E. R. O.		1			9	17	26	29	20	39	16	33	53	36	57	41	14	16	0	11	
Private practice		Freeman (Baldwin, p. 251)		1	39	30	22	29	19														
Iowa Milk stat.	18,188	Baldwin, '21		3	19	20	15	18	17														
Sums, weighted					364	324	296	268	502	797	972	1135	1274	1444	2080	2370	2345	1622	1065	566	125	98	25
Divisors					15	17	18	16	30	46	47	51	51	51	54	54	54	42	41	34	18	6	5
Weighted averages					2427	1906	1644	1675	1673	1733	2068	2225	2498	2831	3852	4389	4342	3862	2597	1723	694	163	50

TABLE F. ABSOLUTE SPAN IN MILLIMETERS.

Age, years		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Over 17
Avr. Orphan Asylum	frequen.		(5)	(13)	(12)	(22)	(18)	(11)	(13)	(10)	(14)	(7)	(7)	(7)			
	♂		975.6	1026.4	1106.6	1142.0	1227	1278.2	1306.3	1366.6	1441.5	1480	1504	1630			
Avg. Ernst, '06	♂						1273	1278	1334	1368	1411	1479	1507				
Avg. Weissenberg, '11	♂	868	937	1005	1085	1132	1172	1203	1267	1331	1393	1431	1481	1575	1639	1692	1700
Avg. Orphan Asylum	f	(4)	(2)	(6)	(12)	(7)	(15)	(13)	(11)	(14)	(16)	(16)	(16)	(8)	(13)	(19)	(198)
	♀	872	918.5	980.7	1065	1158	1205	1278	1337.5	1375	1447.5	1505	1540	1593.5	1591	1609	1617
Avg. Ernst, '06	♀						1242	1258	1351	1376	1424	1503	1518				
Weissenberg, '11	♀				1049	1112	1162	1231	1286	1321	1388	1462	1516	1530	1571	1563	1585

TABLE G. RELATION OF SPAN TO STATURE.

Age, years		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Over 17
Avg. Orphan Asylum	frequen.		(5)	(13)	(12)	(12)	(18)	(11)	(13)	(10)	(14)	(7)	(7)	(7)			
	♂		98.6	98.9	98.4	99.5	100.2	100.8	100.7	100.3	100.8	100.7	100.1	101.4			
Avg. Ernst, '06	♂						101.0	101.4	101.6	101.8	101.7	102.5	103.3				
Avg. Orphan Asylum	f	(4)	(2)	(6)	(12)	(7)	(15)	(13)	(11)	(14)	(16)	(16)	(16)	(7)	(13)	(19)	(198)
	♀	959	98.5	96.9	97.9	98.7	99.4	99.2	99.7	99.6	100.3	99.7	100.2	100.8	100.6	100.8	100.6
Avg. Ernst, '06	♀						100.3	100.4	101.0	100.3	101.7	101.3	101.0				

HUMAN BLOOD GROUPS: THEIR INHERITANCE AND RACIAL SIGNIFICANCE*

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INTRODUCTION

This paper is a presentation of some racial considerations evolving from the heredity and distribution of the blood groups among human beings.

In previous papers (Snyder 1924a, b, c; 1925) the general question of the blood groups has been taken up. It was pointed out that they occur rarely, if at all, in the lower animals. Recently evidence has been brought forward that they may occur in the anthropoid apes (Landsteiner and Miller 1925, Hirszfeld, L. 1926). In the human race the blood groups occur as fixed bio-chemical conditions, subject to the laws of heredity. As such they provide a method of studying racial origins and relationships.

Blood groups were first discovered by Landsteiner (1900) and Shattock (1900) working independently. They found that there were definite substances in the serum of some bloods that would agglutinate, or clump, the cells of certain other bloods. On the basis of the agglutinating reactions, blood can be classified into four groups. Two classifications, the Moss and the Jansky, are in current use. The Jansky classification is recognized as having priority rights, and is used here. The scheme of this classification is given in table 1.

The specific substances in the serum, causing the clumping of the cells, are known as agglutinins. The equally specific receptors in the red cells

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TABLE 1. SCHEME OF THE JANSKY CLASSIFICATION OF BLOOD GROUPS.

Group	Effect of serum	Capacity of cells
I	Agglutinates cells of II, III, IV.	Not agglutinated by any serum.
II	Agglutinates cells of III and IV.	Agglutinated by serum of I and III.
III	Agglutinates cells of II and IV.	Agglutinated by serum of I and II.
IV	Does not agglutinate any cells.	Agglutinated by serum of I, II and III.

are designated agglutinogens. Agglutinogen A is the one found in group II. Agglutinogen B is the one found in group III. Group IV contains both, while group I contains neither.

The four blood groups, thought at first to be present only in diseased persons, were soon found to be of general occurrence. Within each race there occur fairly definite and characteristic proportions of the four groups. As few unit characters are yet known in man, the blood groups form a welcome addition to the list, since they can be accurately studied on a bio-chemical basis, and, depending as they apparently do, on two dominant mutations at the same genetic locus, they afford a means of investigating racial origins and relationships by correlating the frequencies of the hereditary factors concerned.

Observations on the proportions of the four groups among peoples have been made by physicians in all parts of the world. The occurrence of groups having from its very nature presented itself first as a medical problem, it is natural that the practical applications have been chiefly in blood transfusion and medico-legal cases, so that until very recently scarcely more than a paper or two on the subject has been found outside the medical literature. Thus far observations have been reported individually, mainly in the form of figures, and in only a few cases has any attempt been made to correlate the observations with other reports.

It is of interest to compare the results found on the basis of the blood groups with the known racial relationships based on anthropological criteria. Such a procedure, however, as I have already pointed out, (Snyder 1925) must be undertaken with extreme caution. The rarity of pure races, the fact that racial characters are in general blending in inheritance and not sharply defined in succeeding generations following race mixture, while the blood group factors are unit factors with complete dominance, retaining their identity from generation to generation, the great racial divergences that have obviously occurred since the blood group factors became integral parts of the hereditary complex, and the possibility of linkage of the blood group factors with susceptibility to specific disease, all combine to make the problem a difficult one.

Although most of the early investigators of the blood groups reported the frequency of the groups in the peoples among which their observations were made, the first work undertaken for the express purpose of

studying the group frequency in various parts of the world was that of Hirszfeld and Hirszfeld (1919). These authors took advantage of the concentration of nationalities in the Macedonian battlefront during the war, and studied five hundred members of each of sixteen different peoples. They reported the frequency of occurrence of each of the four groups in each of the nationalities. They found that the sixteen peoples could be roughly divided into three types, as follows. One type contained a high percentage of agglutinogen A, and a correspondingly low percentage of B. This type comprised nearly all the European countries, and was therefore named the European type. Another type contained a high frequency of B and a correspondingly low percentage of A. The Mongolian and Ethiopians fell into this category, and it was accordingly named the Asio-African type. The third type, which the authors called the Intermediate type, contained approximately equal proportions of A and B, and comprised Russians, Turks, Arabs and Jews.

The Hirszfelds suggested a "biochemical index" for reporting on group distribution. This was to be arrived at by dividing the percentage of A in a given race by the percentage of B; in other words, by dividing the percentage of groups II and IV (which contain A) by the percentage of groups III and IV (which contain B). It will thus be seen that a race having twice as much A as B would have a bio-chemical index of 2, while a race having only half as much A as B would have an index of 0.5. Of the Hirszfelds' three types, the European type had an index of 2.5–4.5. the Asio-African type showed an index of 0.5–1.09, and the Intermediate type varied from 1.3 to 1.8. Later reports from other investigators have given indices of intergrading magnitude, so that the three types are no longer sharply defined. Furthermore the index is not based on sound mathematical reasoning, and must be discarded entirely, as has already been pointed out (Snyder 1925, Bernstein 1925). In its place must be used the frequency of each of the factors concerned.

The work of the Hirszfelds stimulated a large number of workers in various parts of the world to study other peoples, and bio-chemical indices of various nationalities have been determined everywhere. In general authors have been content to report the frequencies of the groups, the bio-chemical index, and the technique used, without attempting to draw conclusions.

I use in this paper the terms "nationalities" or "peoples," where other authors have used the term "races." This distinction must be carefully drawn from the anthropological standpoint. The study of the American Indians reported in this paper is the nearest approach to a true "racial" study of blood groups.

Schütz and Wölisch (1924), from a study of the blood groups of Germans, note variations in the percentages of the four groups in different parts of Germany. They conclude that the point is not proven that the group frequencies are characteristic of the race. For the various parts of Germany they have only small numbers, however, and the average of all their figures is in close agreement with those of other investigators in Germany. Moreover, the German nationality is not a racial unit. In general, where sufficiently large numbers are used, the results of different investigators in the same country are in close agreement, and I see no necessity of considering seriously the objection of Schütz and Wölisch.

It has been amply established that the agglutinogens are present at birth, but that the agglutinins may be delayed in their appearance for several months (von Dungern and Hirszfeld 1910, Hirszfeld and Hirszfeld 1919, Jones 1921, Robertson, Brown and Simpson 1921, Unger 1921, de Biasi 1923, Kirihara 1924). Tebbutt and McConnel (1922), noting this, suggest that the agglutinogens probably preceded likewise in evolution.

This assumption, however, is not warranted by the fact that primitive or isolated peoples show a very high percent of group I. As will appear later, group I reaches more than 90% among full-blooded American Indians. The peoples which show more than 50% of group I are the American Indians, the Filipinos, the Melanesians of New Guinea, the South African natives, the Australian aborigines, and the Icelanders: all island folk or otherwise isolated.

In order that the distribution of the groups may be used in studies of racial relationships, it must be shown that they are hereditary, and the mode of their inheritance must be demonstrated. Only then can the frequency of each factor be computed, and a classification of races be made.

THE INHERITANCE OF THE GROUPS

The heredity of the groups has long been assumed to be on the basis of two independent pairs of factors, the agglutinogens (A and B) being dominant to their respective iso-agglutinins (a and b). This hypothesis, proposed fifteen years ago by von Dungern and Hirszfeld (1910), was based on inheritance studies of 72 families, comprising 348 individuals. The hypothesis was accepted and confirmed by all later investigators who made inheritance studies on the blood groups of families (Learmonth 1920, Weszeczky 1920, Ottenberg 1921, 1922, 1923, Keynes 1922, Tebbutt and McConnel 1922, Jervell 1923, Dyke and Budge 1923,

Kirihara 1924, Plüss 1924, Mino 1924, Hirszfeld, Hirszfeld and Brokman 1924) with the exception of Buchanan (1923) whose lack of grasp of the whole situation has already been referred to (Snyder 1924b). More than six hundred families have been studied altogether by these various investigators.

Recently, however, Bernstein (1925) has denied the theory of two independent pairs of factors, and has proposed in its place the hypothesis that the blood groups are inherited as a series of three multiple allelomorphs. He bases this not on any study of family inheritance, but entirely on mathematical considerations of the group percentages in various peoples as reported by other invesitgators.

He assumes that the agglutinogens (A and B) are both dominant to the same recessive, which he calls R. The heterozygote AB forms group IV. This theory takes the agglutinins out of hereditary control, leaving only the agglutinogens to be inherited. It requires a different immunological explanation (see Bernstein 1925, pp. 246–248), which, however, could probably be assumed if the facts of the inheritance of the groups really support the hypothesis. The genetic formulae of the four groups for both hypotheses are given in table II. Our American usage would require A, a′ and a as the symbols for the series of allelomorphs, but the agglutinogens have been known as A and B for so long that it seems advisable to retain these symbols, using R to represent the recessive.

TABLE II. GENETIC FORMULAE OF THE FOUR BLOOD GROUPS

Group	Two independent pairs of factors	Three multiple allelomorphs	Group	Two independent pairs of factors	Three multiple allelomorphs
I	aabb	RR	III	aaBB, aaBb	BB, BR
II	AAbb, Aabb	AA, AR	IV	AABB, AaBB, AABb, AaBb	AB

The facts upon which the hypothesis of three multiple allelomorphs is based are these. Since A and B are separate mutations, group IV (AB) must originate by unions of A and B. Knowing the proportions of group II (A) and group III (B) in any race, the proportion of group IV (AB) can be calculated. On the basis of two independent pairs of factors, this would be done as follows. Let p equal the frequency of A, q equal the frequency of a, r equal the frequency of B, and s equal the frequency of b. Then $p + q = 1, r + s = 1$. The possible combinations of these factors are expressed by the equation $(p + q)^2 \cdot (r + s)^2 = 1$. From this the following combinations may be formed.

	AA	2Aa	aa	2Bb	2AABb	4AaBb	2aaBb
	p^2	$2pq$	q^2	$2rs$	$2p^2rs$	$4pqrs$	$2q^2rs$
BB	AABB	2AaBB	aaBB	bb	AAbb	2Aabb	aabb
r^2	p^2r^2	$2pqr^2$	q^2r^2	s^2	p^2s^2	$2pqs^2$	q^2s^2

From this the proportions of the four groups are reckoned as follows.

Group I $=q^2s^2$
Group II $=p^2s^2+2pqs^2=s^2(1-q^2)$
Group III $=q^2r^2+2q^2rs=q^2(1-s^2)$
Group IV $=p^2r^2+2pqr^2+2p^2rs+4pqrs=(1-q^2)\ (1-s^2)$

From the first three above, s^2 and q^2 are calculated.

$$s^2=\frac{I}{I+III} \qquad\qquad q^2=\frac{I}{I+II}$$

When the percentage of group IV is calculated on this basis, it does not agree with the percentage actually found, but is always very much higher than the observed percentage. For example, the percentage of group IV reckoned for English is 6.5. The observed percentage is only 3.0. The calculated percentage for Greeks is 15.5. The observed percentage is only 4.0. This discrepancy holds throughout all of the races studied.

When, however, the percentage of group IV is calculated on the basis of three multiple allelomorphs, it agrees more accurately with the observed percentage. This is done as follows. Let p equal the frequency of A, q equal the frequency of B, and r equal the frequency of R. Then $p + q + r = 1$. The possible combinations of these factors are expressed by the equation $(p + q + r)^2$. From this the following combinations are formed.

	A	B	R
	p	q	r
A	AA	AB	AR
p	p^2	pq	pr

B	AB	BB	BR
q	pq	q^2	qr
B	AB	BR	RR
r	pr	qr	r^2

From this the proportions of the four groups are reckoned as follows.

Group I $=r^2$
Group II $=p^2+2pr$
Group III $=q^2+2qr$
Group IV $=2pq$

From this, p, q, and r are calculated.

$$I+II=r^2+2pr+p^2=(r+p)^2 \qquad I+III=r^2+2qr+q^2=(r+q)^2$$

$$p=1-\sqrt{I+III} \qquad q=1-\sqrt{I+II} \qquad r=\sqrt{I}$$

When the percentages of group IV are reckoned on this basis, the agreement is very close. Using the same examples, the observed percentage of group IV in English is 3.0, while the calculated percentage is 2.8. The observed percentage in Greeks is 4.0, while the calculated percentage is 5.6. These relations are much closer than those based on the theory of two independent pairs of factors. Also the equation $p + q + r = 1$ is in each race very accurately fulfilled.

Thus it is seen that the mathematical considerations of the mass data support the hypothesis of three multiple allelomorphs. There are yet to be considered, however, the inheritance studies of individual

families. When these are examined, it is found that there are frequent cases which are in opposition to the hypothesis of three multiple allelomorphs. The inheritance results to be expected on the two hypotheses are the same except where a parent of group IV is involved. A comparison of the two hypotheses in this respect is given in table III.

TABLE III. THEORETICAL RESULTS OF BLOOD GROUP CROSSES

Mating	Two independent pairs of factors	Three multiple allelomorphs
I×I	I	I
I×II	I, II	I, II
II×II	I, II	I, II
I×III	I, III	I, III
II×III	I, II, III, IV	I, II, III, IV
III×III	I, III	I, III
I×IV	I, II, III, IV	II, III
II×IV	I, II, III, IV	II, III, IV
III×IV	I, II, III, IV	II, III, IV
IV×IV	I, II, III, IV	II, III, IV

It is seen that crosses involving a parent of group IV may be used as critical tests of the merits of the two hypotheses. Crosses of I×IV are especially good tests.

Thirteen investigators have recorded the results of studies on the inheritance of blood groups in families. Of these Weszeczky (1920) did not record any instances where group IV was involved. Six authors (Keynes 1922, Tebbutt and McConnel 1922, Ottenberg 1922, Jervell 1923, Mino 1924, Hirszfeld, Hirszfeld and Brokman 1924) recorded matings involving group IV where no contradictions to the multiple allelomorph hypothesis occur. These results likewise offer no contradiction to the hypothesis of independent factors, however, and were used by the respective authors in upholding this hypothesis, since the later hypothesis was as yet unpublished. Six authors (von Dungern and Hirszfeld 1910, Learmonth 1920, Buchanan 1923, Dyke and Budge 1923, Kirihara 1924, Plüss 1924) have recorded cases involving group IV where the results support the hypothesis of independent pairs of factors, but contradict the multiple allelomorph hypothesis. These exceptions are given in table IV.

It will be seen that according to these authors unions involving group IV may result in offspring of any of the four groups. This type of result occurs too frequently to be lightly overlooked. Thus it is seen that while statistical considerations of the mass data support the multiple allelomorph hypothesis, the studies of individual families tend in some instances to contradict it.

TABLE IV. RECORDED EXCEPTIONS TO THE HYPOTHESIS OF THREE MULTIPLE ALLELOMORPHS

Author	Instance	Mating	Offspring
von Dungern and Hirszfeld 1910....	family 39	I×IV	I, II
	family 46	III×IV	I, I, I
	family 71	III×IV	I, II, II, III, IV
	family 72	I×IV	I, IV, IV, IV
Learmonth 1920................	family 23	I×IV	IV, IV
	family 29	I×IV	IV, IV, IV, IV, IV, IV
	family 38	I×IV	IV, IV, IV, IV
Buchanan 1923..................	fig. 6	I×IV	I, II
	fig. 13	I×IV	I, I, I, I, IV
	fig. 19	II×IV	I, IV
	fig. 20	I×IV	I
Dyke and Budge 1923............	one family	II×IV	I
Plüss 1924......................	6 families	I×IV	I, II, III*
Kirihara 1924....................	family 6	II×IV	I
	family 117	I×IV	II, IV, III, III, III
	family 126	III×IV	III, III, III, III, I, III

*Number of children not given. "Gruppe IV und I sind in 6 Familien vertreten. Die Kinder zeigen Gruppe III, II oder I . . . . Eltern mit Gruppe IV und II und Gruppe IV und III haben Nachkommen von allen vier Gruppen."

With these facts in mind, studies of family inheritance were undertaken by the writer in connection with this investigation. A total of 200 families, involving 1095 individuals, has been studied. This is by far the largest family blood group study yet recorded. Some of these families were obtained among the friends and acquaintances of the author and some in coöperation with the N. C. State Board of Health, through the courtesy of Dr. Taylor, to whom my thanks are due. All of the families reside in North Carolina. In each case the blood was grouped within a few hours after the samples were taken. The results are given in table V. Nine cases involving a parent of group IV were met with. In no one of these was a child of group I found. The results support the hypothesis of three multiple allelomorphs, although they offer no direct contradiction to either hypothesis. In view of the fact that the mass data support the multiple allelomorph hypothesis, these results must be taken as also upholding it.

TABLE V. INHERITANCE OF BLOOD GROUPS IN FAMILIES

Showing in condensed form the results of the inheritance studies of 200 families made in connection with this investigation.

Mating	No. of families	Children in group I	II	III	IV
I×I	44	151			
I×II	73	88	176		
II×II	32	15	88		
I×III	22	25		41	
II×III	17	9	15	14	23
III×III	3			12	
I×IV	5		10	13	
II×IV	3		6	2	4
III×IV	1			2	1
IV×IV	0				

Another set of critical tests of the two hypotheses is in the percent of the groups expected in matings involving group IV. Here the results of my study support absolutely the multiple allelomorph hypothesis; and the combined results of all investigators seem also to support it, even where the individual families tend in some instances to contradict it. In the case of unions of I × IV, the results on the basis of three multiple allelomorphs would be as follows: 2AB × RR = AR + BR = 50% group II: 50% group III. The results on the basis of two independent pairs of factors would be as follows: (AABB + 2AaBB +2AABb + 4AaBb) × aabb = 4AaBb + 2Aabb + 2aaBb + aabb = 44.4% group IV: 22.2% group II: 22.2% group III: 11.1% group I. Similar percentages can be calculated for unions of II × IV and III × IV. The observed percentages for these unions are given in tables VI, VII, and VIII. Unions of IV × IV are very rare, only two instances having been recorded. Neither of these offer contradictions to either hypothesis. It can be seen from these tables that the observed percentages are closer to those required by the hypothesis of three multiple allelomorphs than to those required on the basis of two independent pairs of factors.

TABLE VI. RECORDED UNIONS OF GROUPS I×IV.

Author	No. of families	No. of offspring in group I	II	III	IV
von Dungern and Hirszfeld 1910	4	2	2	2	3
Learmonth 1920	3	0	0	0	12
Keynes 1922	1	0	0	2	0
Tebbutt and McConnel 1922	2	0	7	5	0
Ottenberg 1922	2	0	5	5	0
Buchanan 1923	4	6	2	2	1
Jervell 1923	3	0	5	2	0
Dyke and Budge 1923	1	0	0	1	0
Kirihara 1924	6	1	9	8	0
Plüss 1924	6	*	*	*	*
Mino 1924	4	0	5	4	0
Hirszfeld, Hirszfeld and Brokman 1924	1	0	2	0	0
Snyder, this paper	5	0	10	13	0
Total		9	47	44	16
Per cent observed		7.7	40.5	37.9	13.8
Per cent expected, multiple allelomorphs		0.0	50.0	50.0	0.0
Per cent expected, independent pairs		11.1	22.2	22.2	44.4

*Number in each group not given. "Gruppe IV und I sind in 6 Familien vertreten. Die Kinder zeigen Gruppe III, II oder I."

The objection to the multiple allelomorph hypothesis, then, consists of twenty-one families in which some of the children show groups other than those expected. This objection is not so insurmountable as it might seem at first glance. There are recorded among the families studied by the foregoing investigators about as many cases which show contradictions to both hypotheses, that is, to the Mendelian theory of inheritance itself. Nine of these occur in unions of I × II and I × III. These

TABLE VII. RECORDED UNIONS OF GROUPS II×IV

Author	No. of families	No. of offspring in group I	II	III	IV
von Dungern and Hirszfeld 1910	2	0	3	1	2
Learmonth 1920	3	0	2	0	4
Keynes 1922	1	0	1	0	2
Ottenberg 1922	5	0	4	0	2
Buchanan 1923	1	1	0	0	1
Jervell 1923	3	0	6	1	2
Dyke and Budge 1923	1	1	0	0	0
Kirihara 1924	9	1	8	8	6
Mino 1924	5	0	9	3	4
Snyder, this paper	3	0	6	2	4
Total		3	39	15	27
Per cent observed		3.5	46.4	17.8	32.1
Per cent expected, multiple allelomorphs		0.0	50.0	16.6	33.3
Per cent expected, independent pairs		3.7	29.6	7.4	59.2

TABLE VIII. RECORDED UNIONS OF GROUPS III×IV

Author	No. of families	No. of offspring in group I	II	III	IV
von Dungern and Hirszfeld 1910	3	4	2	4	2
Keynes 1922	1	0	3	1	0
Ottenberg 1922	1	0	0	0	1
Kirihara 1924	6	1	1	10	6
Mino 1924	1	0	0	1	0
Snyder, this paper	1	0	0	2	1
Total		5	6	18	10
Per cent observed		12.8	15.4	46.1	25.6
Per cent expected, multiple allelomorphs		0.0	16.6	50.0	33.3
Per cent expected, indepent pairs		3.7	7.4	29.6	59.2

are recorded in table IX. The most striking exceptions occur in unions of group I, where the children should all be group I. Table X gives all the cases of unions of group I so far recorded.

TABLE IX. EXCEPTIONS TO THE MENDELIAN RULE, OTHER THAN UNIONS OF GROUP I

Author	No. of families	Groups concerned	Exceptions
Weszeczky 1920	1	I×II	1 in group III
	1	I×III	2 in group II
Buchanan 1923	1	I×II	1 in group IV
Mino 1924	4	I×II	3 in group III 4 in group IV
Hirszfeld, Hirszfeld and Brokman 1924	1	I×III	1 in group IV

Exceptions such as these to both hypotheses must be attributed to mistakes in technique or observation, to illegitimacy, or perhaps to the presence of more than four groups in human blood. Illegitimacy will hardly explain all of the exceptions. Mistakes in technique or observation, however, are sometimes made. Too heavy a concentration of cells will sometimes show sedimentation which resembles agglutination. Dirt or grease on the slide will sometimes cause false agglutination.

In Learmonth's exceptions to the multiple allelomorph hypothesis, it is not necessary to assume that the occurrence of twelve group IV

Table X. Recorded Unions of Groups I×I

Author	No. of families	Children in Groop I	Children in another group
von Dungern and Hirszfeld 1910	11	25	——
Learmonth 1920	9	18	1 in group II
Keynes 1922	2	4	——
Tebbutt and McConnel 1922	5	17	——
Ottenberg 1922	12	25	——
Buchanan 1923	8	17	3 in group IV 2 in group III 8 in group II
Jervell 1923	2	5	——
Dyke and Budge 1923	30	30	——
Kirihara 1924	6	20	——
Plüss 1924	12	27	——
Mino 1924	12	31	5 in group II
Hirszfeld, Hirszfeld and Brokman 1924	7	19	——
Snyder, this paper	44	151	——

children was due to mistakes in technique. If it is assumed that the group I parent was really group II or group III, a fact which might have been overlooked, the single mistake in grouping the parent explains all of the children.

The series of facts tending to indicate the presence of more than four groups in human blood are not well understood as yet, but may have significance when further investigated. These facts have been presented by Coca and Klein 1923, Vorschütz 1923, Guthrie and Huck 1923, Guthrie and Pessel 1923a, b, Guthrie, Pessel and Huck 1924, Tebbutt 1924, Kline, Ecker and Young 1925.

If exceptions to the Mendelian rule due to mistakes in technique, to illegitimacy, or to other causes, can occur, we must grant an equal number of such exceptions to the theory of three multiple allelomorphs. All in all, it would seem that the hypothesis of two independent pairs of factors must be discarded, however reluctantly.

THE DISTRIBUTION OF THE GROUPS

Assuming, then, that the blood groups are inherited as three multiple allelomorphs, let us see what can be done in the way of classifying peoples on this basis. As has already been stated, the bio-chemical index must be discarded. This invalidatas Hirszfeld and Hirszfelds' three categories. Ottenberg (1925) perceiving the fallacy of the bio-chemical index, has made a new classification of peoples, recognizing six types. These are based directly on the percentages of the four groups. A more accurate classification can be made, however, based on the frequency of each of the three factors, that is, based on p, q, and r. This I have done, and the results may be understood from tables XI and XII. Table XI gives the percentages of the four groups in different nationalities as

determined by various investigators. The table shows the name of the people, the authority responsible, the number of individuals studied, and the percent of each group. I have calculated p, q, and r for each people. Nearly fifty nationalities have been studied by various investigators, some in great detail. In this table are included original results on the group percentages of Dutch, Maltans, American Indians, American negroes, and various types of white Americans (normal, epileptic, dementia praecox and feeble-minded).

The classification has been made on the basis of the frequencies p, q, and r. As representing the frequencies of the two mutations, p and q have been used in the correlation table. The frequency r need not be considered, since two peoples having similar percentages of p and q will have similar percentages of r. Table XII shows this correlation in graphical form. Even in this classification, a certain empirical manner of grouping must be admitted, since p and q have been lumped into five percent classes. This is about as near an accurate classification as can be made, however. Each square in the correlation table contains nationalities which agree in their frequencies p, q, and r. From this table it can be seen that Ottenberg's six classes, based merely on the proportions of the groups, were nevertheless well chosen. Some discrepancies show up, however. The Icelanders have frequencies almost identical with those of the Danes, and should be included in the European group. The Australian aborigines fall nearer to the European type than to any other, but probably should be placed in a class by themselves. All Koreans do not belong to the Indomanchurian type, but Southern Koreans belong in the so-called "Hunan Type," with the Japanese. Roumanians, Bulgarians and Polish Jews seem to be similar in their frequencies to the races of the Intermediate type, and should probably be included in this type. Other minor discrepancies will be pointed out as the various races are discussed. I would suggest the changing of the name "Africo-South Asiatic type" to "Africo-Malaysian type" as being more truly descriptive of the included races. In table XI are listed the results of about forty investigations which do not appear in Ottenberg's paper. These represent twelve additional peoples, and many regional studies.

The grouping of peoples into "types" is purely arbitrary, merely for the sake of convenience in dealing with the data. The first necessary step in considering the blood group data is to arrange it in some sort of logical order. Some of the types are sharply defined. In others the line is hard to draw. In any case, further study will doubtless necessitate changes, so that the present types can not be considered at all fixed.

TABLE XI. PERCENTAGES OF THE FOUR BLOOD GROUPS AMONG VARIOUS PEOPLES, WITH THE FREQUENCY OF EACH FACTOR CONCERNED

Race	Investigator	No.	I	II	III	IV	p	q	r
			Percent in group						
EUROPEAN TYPE									
English	Hirszfeld & Hirszfeld 1919	500	46.4	43.4	7.2	3.0	26.8	5.2	68.1
Americans	Hektoen 1907	——	47.0	34.0	10.0	9.0	24.5	10.0	68.6
	Moss 1910	1600	43.0	40.0	7.0	10.0	29.3	8.9	65.6
	Buchanan & Higley 1921	1536	46.9	40.8	8.5	3.6	25.6	6.4	68.4
	Culpepper 1921	5000	41.0	38.0	18.0	3.0	23.2	11.2	64.0
	Ottenberg 1921	286	44.0	42.0	12.0	2.0	25.2	7.3	66.3
	Snyder, this paper	1000	45.0	42.0	10.0	3.0	25.9	6.8	67.0
(insane)	Snyder, this paper	100	45.0	42.0	9.0	4.0	26.6	6.8	67.0
(epileptics)	Snyder, this paper	100	48.0	41.0	9.0	2.0	24.6	5.7	69.2
(feeble-minded)	Snyder, this paper	175	44.0	42.2	9.7	4.0	26.8	7.2	66.3
French	Hirszfeld & Hirszfeld 1919	500	43.2	42.6	11.2	3.0	26.2	7.4	65.7
Italians	Hirszfeld & Hirszfeld 1919	500	47.2	38.0	11.0	3.8	23.7	7.7	68.7
	Cavalieri 1922	139	35.9	51.0	8.6	4.1	33.3	6.8	59.9
	Mino 1924	1391	35.9	51.1	8.6	4.2	33.3	6.9	59.9
Maltans	Snyder, this paper	150	46.0	44.0	6.0	4.0	27.9	5.2	67.8
Germans (Heidelberg)	Hirszfeld & Hirszfeld 1919	500	40.0	43.0	12.0	5.0	27.9	8.9	63.2
(In Hungary)	Verzar & Weszeczky 1922	476	40.8	43.5	12.6	3.1	26.9	8.2	63.8
	Plüss 1924	543	42.6	43.1	8.8	5.5	28.4	7.5	65.2
(Berlin)	Schiff & Ziegler 1924	750	37.8	39.4	16.4	6.4	26.4	12.1	61.5
(Schleswig-Holstein)	Schütz & Wohlisch 1924	1679	42.7	42.7	11.7	2.9	26.3	7.6	65.3
(Leipzig)	Sucker 1924	1000	34.5	41.5	16.5	7.5	28.6	12.8	58.7
(Keil)	Steffan 1924	500	39.8	42.8	14.0	3.4	26.7	9.2	63.0
German Jews	Schiff & Ziegler 1924	230	42.1	41.1	11.9	4.9	26.6	8.8	64.9
Austrians	Hirszfeld & Hirszfeld 1919	——	42.0	40.0	10.0	8.0	27.9	9.5	64.8
Dutch	Snyder, this paper	200	42.0	44.0	9.0	5.0	28.6	7.3	64.8
Norwegians	Jervell 1923	436	35.6	49.8	10.3	4.3	32.3	7.6	59.7
Swedes	Hesser 1924	533	36.9	46.9	9.7	6.4	31.8	8.5	60.7
	Lindberger 1925	500	33.5	51.0	10.0	5.5	34.1	8.1	57.8
Danes	Johannsen 1921	150	47.3	36.7	12.0	4.0	23.0	8.3	68.8
	Johannsen 1925	512	43.0	42.0	12.0	3.0	25.9	7.9	65.5
Icelanders	Jonsson 1923	800	55.6	32.1	9.6	2.6	19.2	6.4	74.6
Serbians	Hirszfeld & Hirszfeld 1919	500	38.0	41.8	15.6	4.6	26.8	10.7	61.6
Greeks	Hirszfeld & Hirszfeld 1919	500	38.2	41.6	16.2	4.0	26.2	10.7	61.8

TABLE XI. *Continued*

Race	Investigator	No.	Percent in group I	II	III	IV	p	q	r
INTERMEDIATE TYPE									
Arabs	Hirszfeld & Hirszfeld 1919	500	43.6	32.4	19.0	5.0	20.9	12.9	66.0
Turks	Hirszfeld & Hirsafeld 1919	500	36.8	38.0	18.6	6.6	25.6	13.6	60.7
Russians	Hirszfeld & Hirszfeld 1919	1000	40.7	31.2	21.8	6.3	21.0	15.2	63.8
Slovaks	Manuila 1924	461	44.7	31.3	15.8	8.2	22.3	12.9	66.8
Spanish Jews	Hirszfeld & Hirszfeld 1919	500	38.8	33.0	23.2	5.0	21.3	15.3	62.3
Roumanians	Manuila 1924	1521	33.7	43.3	15.6	7.4	29.8	12.3	58.2
	Weszeczky 1920	——	32.1	34.5	16.1	17.3	30.6	18.4	56.6
(mountains)	Popoviciu 1924	2372	36.5	40.9	14.5	7.9	28.6	12.1	60.4
(valleys)	Popoviciu 1924	1278	33.5	41.2	19.0	6.3	27.5	13.6	57.8
Bulgarians	Hirszfeld & Hirszfeld 1919	500	39.0	40.6	14.2	6.2	27.1	10.8	62.4
(in Roumania)	Manuila 1924	372	31.5	45.4	14.8	8.3	32.0	12.4	56.1
Polish Jews	Halber & Mydlarski 1925	818	33.1	41.5	17.4	8.0	28.9	13.6	58.0
Armenians	Parr (personal commu'c't'n)	213	22.5	51.6	13.1	12.6	40.3	14.0	47.4
HUNAN TYPE									
South Chinese (Hunan)	Chi-Pan 1924	1296	31.8	38.8	19.4	9.8	28.5	16.0	56.3
(Setshuan)	Liang 1924	——	44.8	28.9	23.7	2.6	17.3	14.2	66.9
(Tschekiang)	Liang 1924	——	37.0	29.8	22.5	10.7	22.9	18.3	60.8
(Kuangtung)	Liang 1924	——	40.4	31.4	23.8	4.8	20.1	15.6	63.2
North Japanese (Sendai)	Matsubara 1920	151	32.5	37.0	19.2	11.3	28.1	16.6	57.0
(Sendai)	Ninomiya 1925	642	29.4	39.3	21.5	9.8	28.7	17.2	54.2
(Sendai)	Mitomo	468	29.1	39.7	21.6	9.6	28.8	17.1	53.9
Middle Japanese (Nagano)	Hara & Kobayashi 1916	353	24.4	40.5	16.0	20.0	36.8	19.7	49.0
(Tokyo)	Nakajima	501	31.5	38.5	22.4	8.0	26.6	16.4	56.1
(Tokyo)	Shirai	317	30.5	37.5	21.5	10.4	27.9	17.6	55.2
(Kyoto)	Nakajima	509	28.7	41.7	20.2	9.4	30.1	16.1	53.5
South Japanese (Fukuoka)	Torii 1922	87	23.0	46.0	20.0	11.0	34.5	17.0	47.9
	Fukamachi 1923	363	26.8	40.9	18.4	13.9	32.9	17.8	51.1
Japanese (In Korea)	Kirihara 1924	502	29.4	42.2	20.6	7.8	29.3	15.4	54.2
South Koreans (Zennan)	Kirihara 1924	171	19.9	41.5	25.7	12.9	32.5	21.6	44.6
Hungarians	Weszeczky 1920	——	26.3	38.1	18.8	16.8	32.9	19.8	51.2
	Verzar & Weszeczky 1922	1500	31.0	38.0	18.8	12.2	29.4	17.0	55.6
	von Jeney 1923	1172	22.3	31.6	27.4	18.7	29.6	26.6	47.2
	Manuila 1924	688	27.8	40.8	20.2	11.2	30.7	17.2	52.7
Poles	Halber & Mydlarski 1925	11488	32.5	37.6	20.9	9.0	26.9	16.3	57.0
Ukranians	Manuila 1924	400	18.0	39.2	22.5	20.3	36.4	24.4	42.4
Roumanian Jews	Manuila 1924	211	26.1	38.8	19.8	15.3	32.4	19.5	51.0

INDOMANCHURIAN TYPE									
North Chinese (Pekin)	Liu & Wang 1920	1000	30.7	25.1	34.2	10.0	19.5	26.0	55.4
(Shantung)	Liang 1924	—	21.1	31.6	36.8	10.5	24.0	27.5	45.9
(Nganhai)	Liang 1924	—	47.9	21.7	21.7	8.7	16.6	16.6	69.1
(Kiangsu)	Liang 1924	—	39.0	29.7	26.4	4.9	19.2	17.2	62.4
Chinese	Kilgore & Liu 1918	100	28.0	36.0	25.0	11.0	27.2	20.0	52.9
(In United States)	Coca & Diebert 1923	111	29.0	32.0	29.9	10.0	23.8	21.9	53.8
North Koreans (Heihoku)	Kirihara 1924	354	30.5	27.4	34.5	7.6	19.4	23.9	55.2
Middle Koreans (Keiki)	Kirihara 1924	311	27.3	32.8	32.8	7.1	22.5	22.5	52.2
(Chuhoku)	Kirihara 1924	112	17.9	36.6	33.7	12.5	28.2	26.2	42.3
(Seoul)	Fukamachi 1923	179	24.5	35.7	25.1	14.5	29.5	22.3	49.6
(Phyengyang)	Fukamachi 1923	184	31.5	29.9	27.7	10.8	23.1	21.6	56.1
Manchus	Fukamachi 1923	199	26.6	26.6	38.2	8.5	19.5	27.0	51.5
Indians (natives of India)	Hirszfeld & Hirszfeld 1919	1000	31.3	19.0	41.2	8.5	14.9	29.1	55.9
Gypsies	Verzar & Weszeczky 1922	385	34.2	21.1	38.9	5.8	14.5	25.6	58.4
Ainus	Ninomiya 1925	205	19.0	32.7	34.5	13.7	26.9	28.1	43.5
AFRICO-MALAYSIAN TYPE									
Senegalese	Hirszfeld & Hirszfeld 1919	500	43.2	22.6	29.2	5.0	14.9	18.9	65.7
South Africans	Pirie 1921	250	52.0	27.2	19.2	1.6	15.6	11.0	72.1
Madegascans	Hirszfeld & Hirszfeld 1919	400	45.5	26.2	23.7	4.5	16.8	15.4	67.5
American negroes	Lewis & Henderson 1922	270	49.0	26.9	18.4	5.5	18.0	13.0	70.0
	Snyder, this paper	500	47.0	28.0	20.0	5.0	18.2	13.4	68.5
Melanesians (New Guinea)	Heydon & Murphy 1924	753	53.7	26.8	16.3	3.2	16.4	10.3	73.2
Annamese	Hirszfeld & Hirszfeld 1919	500	42.0	22.4	28.4	7.2	16.1	19.8	64.8
Javanese	Bais & Verhoef 1924	1346	39.9	25.7	29.0	5.4	17.0	19.1	63.1
Sumatrans	Bais & Verhoef 1924	546	43.7	23.0	29.0	4.3	14.8	18.4	66.1
Sumatran Chinese	Bais & Verhoef 1924	592	40.2	25.0	27.6	7.2	17.7	19.3	63.4
PACIFIC-AMERICAN TYPE									
North American Indians	Coca and Diebert 1923	862	77.7	20.2	2.1	0.0	10.7	1.1	88.0
	Snyder, this paper	1104	79.1	16.4	3.4	0.9	9.2	2.3	88.9
(full-blooded)	Snyder, this paper	453	91.3	7.7	1.0	0.0	4.0	0.6	95.5
Filipinos	Cabrera & Wade 1921	204	64.7	14.7	19.6	1.0	8.2	10.9	80.4
AUSTRALIAN TYPE									
Australian aborigines	Tebbutt & McConnel 1922	204	57.0	38.5	3.0	1.5	22.6	2.3	75.5

TABLE XII. Correlation of p and q Among Various Peoples of the World.

q \ p	0 – 5	6 – 10	11 – 15	16 – 20	21 – 25	26 – 30	31 – 35
0 – 5	AMERICAN INDIANS	AMERICAN INDIANS			AUSTRALIANS		
6 – 10		FILIPINOS		ICELANDERS	DANES	AMERICANS ENGLISH FRENCH ITALIANS MALTANS GERMANS GERMAN JEWS AUSTRIANS DUTCH SERBS GREEKS	NORWEGIANS SWEDES
11 – 15			SO. AFRICANS	AMER. NEGROES MADEGASCANS MELANESIANS	ARABS TURKS RUSSIANS SPANISH JEWS CZECHS	ROUMANIANS BULGARIANS POLISH JEWS	ARMENIANS
16 – 20			SENEGALESE SUMATRANS	ANNAMESE JAVANESE SUMATRAN CHINESE	SO CHINESE	SO. CHINESE NO. JAPANESE HUNGARIANS POLES	MID. JAPANESE SO. JAPANESE ROUMANIAN JEWS
21 – 25				NO KOREANS	MID. KOREANS		SO. KOREANS UKRANIANS
26 – 30			NATIVES OF INDIA GYPSIES	NO. CHINESE MANCHUS		AINUS	

These types, then, represent peoples who are similar in their frequencies p, q, and r. Because two peoples occur in the same type, it is not implied that they have the same racial history, but only that they contain similar amounts of A and B. The amount of A or B may have been obtained in the same way by the various peoples in each class, or it may not. These questions will be further considered later on.

It can readily be seen from tables XI and XII that agglutinogen A occurs most frequently among North European peoples, and becomes less and less frequent to the east, with the exception of a sudden rise in Southern Korea and Japan. On the other hand, B occurs most frequently in India and the Orient, becoming less frequent to the west. This leads to the obvious assumption that these dominant mutations occurred separately, in different regions, in the early development of mankind, and were brought together by mutual infiltration of the respective races bearing them.

Besides the heredity of the groups, two other facts must be demonstrated if the blood groups are to be used as criteria for the study of racial relationships. These are, first, that there is a definite effect on group percentages due to crossing, and second, that the proportions of the groups remain constant from generation to generation in the absence of crossing. Both of these events are logically and mathematically to be expected in the absence of selection, but an actual demonstration is valuable.

To show the effects of crossing on the proportions of the groups, the author chose the American Indians. Coca and Diebert (1924) had already shown that the proportion of group I in this race was very high (77.7%). This led me to believe that it might be demonstrated that full-blooded Indians were all group I, and that the presence of the other groups was due to white admixture. Accordingly 1134 Indians have been studied and their blood grouped. The results are shown in table XIII. The blood from the 250 Cherokees was obtained personally. The blood from the other reservations was sent me by the agency physicians. To the superintendents and physicians of the various agencies I am greatly indebted. The manner of sending blood for distances is discussed later under technique.

Table XIII. Blood Group Proportions of American Indians

Reservation	Number studied	Percent in group I	II	III	IV
Asylum for Insane Indians, Canton, S. D.	95	70.5	25.2	4.2	0.0
Cherokee Agency, Cherokee, N. C.	250	74.4	16.0	7.2	2.4
Choctaw-Chickasaw Sanatorium, Talihina, Okla.	137	89.7	9.4	0.7	0.0
Coeur d'Alene Agency, De Smut, Idaho	25	100.0	0.0	0.0	0.0
Crow Creek Agency, Ft. Thompson, S. D.	100	91.0	7.0	2.0	0.0
Distrito Federal, Mexico	31	64.5	25.8	6.4	3.2
Ft. Bidwell Agency, Ft. Bidwell, Cal.	46	89.1	8.7	2.2	0.0
Hayward School, Hayward, Wis.	40	75.0	17.5	5.0	2.5
Hopi Agency, Keams Canon, Ariz.	52	84.6	15.4	0.0	0.0
Keshena Agency, Keshena, Wis.	25	88.0	12.0	0.0	0.0
Navajo Agency, Ft. Defiance, Ariz.	48	83.3	10.4	6.3	0.0
Pine Ridge Agency, Pine Ridge, S. D.	25	92.0	8.0	0.0	0.0
Ponca Agency, Whiteagle, Okla.	100	84.0	11.0	3.0	2.0
Rosebud Agency, Rosebud, S. D.	40	70.0	27.5	2.5	0.0
Sac and Fox Sanatorium, Toledo, Iowa	60	71.6	26.6	1.6	0.0
Shoshone Agency, Ft. Washakie, Wyo.	60	51.6	45.0	1.6	1.6
Total	1134	79.1	16.4	3.4	0.9

The proportions of the groups in the American Indians studied agree almost exactly with those found by Coca and Diebert in their study. My results, however, can be subjected to an analysis on the basis of pure and mixed bloods. In many cases it could be stated just which samples were from full-bloods and which were from mixed bloods.

For example, of the 250 Cherokee Indians, 110 were, according to the records and the personal knowledge of the physician, pure, while 140 were known to be mixed with white. The percent of group I in all of the Cherokees studied was 74.4. In those known to be mixed, it dropped to 59.3, much closer to that of the whites, while in those said to be pure it was 93.6. This is a definite indication that full-blooded American Indians are all of group I, and the occurrence of the other groups is due to white admixture. Even those said to be pure may have some trace of white blood, as the records seldom go back more than three or four generations. This would account for the small percentages of groups II and III found among the Indians said to be pure. Similar analyses of mixed and pure bloods were made from many of the other agencies. A few agencies were unable to give pedigrees with the samples. The varying percentages of the four groups in the different agencies is due to the fact that some agencies sent mostly full-bloods, some mostly mixed bloods, and so on.

From these analyses, a graded series can be made, starting with pure Indians, and ending up with whites. This gives an excellent indication of the effect of crossing on the proportions of the groups. This is shown in table XIV.

Table XIV. Graded Series Showing the Effect of Crossing on the Proportions of the Groups

Race	Number studied	Percent in group I	II	III	IV
Indians said to be pure	453	91.3	7.7	1.0	0.0
All Indians (mixed and pure)	1134	79.1	16.4	3.4	0.9
Indians known to be mixed	409	64.8	25.6	7.1	2.4
Americans (white)	1000	45.0	42.0	10.0	3.0

There can be no doubt that racial crossing can profoundly modify the proportions of the groups.

That the group percentages remain constant for a long period of years, even under different environments, has been shown by Verzar and Weszeczky (1922). They found that Gypsies, a people from India living in Hungary for several hundred years, still show the same proportions of the groups as the natives of India studied by Hirszfeld and Hirszfeld. (See table XI). Likewise pure-bred Germans living in Hungary for several generations showed group distributions like the Germans of Germany, quite different from their Hungarian associates.

Some work has been done on the connection of blood groups with disease, a question which becomes important in the light of racial studies. Recently a veritable flood of cases has been presented to show that the blood groups are linked with various constitutional disorders.

In no case is there any conclusive evidence of such linkage. Alexander (1921) from the study of the blood groups of a number of cases, claimed that persons of groups III and IV were peculiarly susceptible to malignant disease. Buchanan and Higley (1921) and Pfahler and Widmann (1922), however, showed that no group was more susceptible than any other. Johannsen (1925), from a study of 263 cases, claimed that persons of groups I and III were less susceptible. Weitzner (1925), in a study of 84 cases of carcinoma, finds that group I is represented to a less degree than in normal persons, and group IV to a greater degree. All of these appear to be chance deviations, due to the small numbers involved.

Hirszfeld, Hirszfeld and Brokman (1924) have attempted to show that susceptibility to diphtheria is linked with the blood groups. The family histories given, however, do not indicate linkage any more than they do free assortment. Fürst (1925) presented some evidence that predisposition to goiter is linked with the blood groups, but the numbers given are very small and not conclusive. Straszynski (1925) stated that the rapidity of the disappearance of the Wassermann reaction under treatment is a constitutional character in correlation with the blood groups.

If the blood group factors should be closely linked with some pathological condition, a means of selection would be available, which might make studies of racial relationships even more complicated. Without such linkage, it is difficult to conceive of any effect of selection on the proportions of the groups.

In this connection the writer studied several hundred cases of epilepsy, insanity, and feeble-mindedness among both whites and Indians. In each of these neuropathic conditions the distribution of the groups agreed with that for normal persons of the same race. See tables XI and XIII. Studies on the blood group distribution among those carried off by plague, influenza, and other world-wide epidemics should be made in this same connection.

The literature with regard to the effect on blood groups of drugs, anesthesia, Roentgen rays, etc., has already been reviewed (Snyder 1924b). In general investigators seem to be in accord that there is no influence on the blood groups of age, sex, vocation, disease, drugs, anesthesia, Roentgen rays, climate or living conditions.

Let us then examine in more detail the peoples which have been studied, and the classification offered here. We shall take each type separately.

The European Type. This type includes all west-European peoples. It has the lowest percent of B found in any peoples with the exception of the American Indians and the Australian aborigines. The percent of A is correspondingly high, being surpassed only among some of the peoples of the Hunan type. From north-west to south-east in Europe the per cent of A decreases. It continues to decrease as we proceed farther east, reaching its lowest ebb in India. Exceptions to this rule are the Armenians, Japanese, Koreans and Australian aborigines, all of whom show a high frequency of A. These will be considered under their own types.

The Maltans and Dutch, whose group percentages are given here for the first time, fall into the European type. For the samples of Maltan blood I am indebted to Dr. T. Zammitt, rector of the University of Valletta, and for the Dutch blood to Prof. Dr. W. Schüffner, of the Institute for Tropical Hygiene, Amsterdam.

Icelanders come nearest to the European type, although their high percent of group I indicates their early separation from continental peoples, and a possible admixture with an American Indian type. Their group proportions, however, are closest to those of the Danes, to whom they are known to be related.

It seems probable that factor A originated in west Europe, and was carried eastward by successive migrations, while factor B was introduced into Europe by westward migrations of Mongolian peoples.

The Intermediate Type. The peoples of the Intermediate type represent a departure from the European type in that the percent of B has increased, and the percent of A has somewhat decreased. The peoples of this type lie geographically intermediate between Europe, with its high frequency of A, and Asia, with its high frequency of B, and show corresponding intermediate blood group proportions.

Popoviciu (1924) has studied the group percentages of the Roumanians in the mountains and in the valleys. The frequency of A falls in the valleys, while the frequency of B increases. Popoviciu attributed this to the fact that the valleys are open and accessible to the surrounding peoples, which has allowed admixture by immigration, while in the inaccessible mountains the race is still pure. The percentage differences are too slight, however, to be of much significance. (See table XI).

The world war has changed the map of Europe since some of these investigations were made. This must be taken into account. An example of this is Yugoslavia, of which the northern part is composed of Hungarians, belonging to the Hunan type, while the southern part is of Serbians, belonging to the European type.

The Hunan Type. This type derived its name from the fact that South Chinese of the province of Hunan are included in it. However, the researches of Liang (1924) on South Chinese of Setshuan, Tschekiang and Kuangtung, indicate that these people belong rather in the Indo-manchurian type. The Hunan type is a difficult one to define. It has an exceptionally high frequency of A, with a low frequency of B. The presence in it of Hungarians, Poles and Ukranians, suggests a possible Mongolian ancestry for these peoples. The inclusion of Japanese and South Koreans indicates that southern Korea and adjacent southern Japan provide an additional center for the spread of agglutinogen A. The question becomes one of the manner in which A originated in this center. Two possibilities present themselves. An independent mutation of A, separate from that in Europe, may have taken place, or A may have been brought to this center by races of the European type, and spread from there. It is known that early in the development of the Asiatic Mongols there was differentiated a race which developed into the Koreo-Japanese group. This group was at its differentiation strongly infused with Caucasic elements. Korea was the original home of the group. The blood group data would tend to confirm this. In this way southern Korea would be an eastern center for the spread of agglutinogen A among Asiatic poeples. The high frequency of A is confined to the immediate vicinity. Thus p drops from 32.5 in south Korea to 19.4 in north Korea and 19.5 in Manchuria; it drops from 34.5 in south Japan to 28.1 in north Japan. On the other hand, q remains rather constant in these regions.

The Indomanchurian Type. This type includes north Koreans, Manchus, Chinese, Ainus, Gypsies and natives of India. It has a high frequency of B, and a rather low frequency of A. The Ainus do not exactly fit in here, but are included for want of a better place. They could as well have been included in the Hunan type. Both agglutinogens are highly developed in the Ainus,and they remain a puzzle from the standpoint of their blood groups, just as they have long been an anthropological puzzle.

The gypsies (Zigeuner) studied by Verzar and Weszeczky are said by these authors to be originally from India. Their blood group proportions agree with those of natives of India, even after these many centuries. The lowest frequency of A, and the highest of B, is found in India.

The high frequency of B in Asia, growing less and less to the west, offers strong evidence that mutation B took place somewhere in Asia,

possibly in India, after the American Indian branch had become isolated.

The Africo-Malaysian Type. This type includes all the Africans yet studied, as well as the Malay peoples. The Malays (Javanese, Annamese, Sumatrans) show a slightly higher frequency of B than the Africans and one is tempted to attribute this to their Mongolian affinities. However, the Senegalese of west Africa have just as high a frequency of B as the Malay races. There is no doubt that both agglutinogens are well developed among both the blacks of the continent and those of the Pacific Islands. Much remains to be done in intensive work among the peoples of Africa.

The Pacific-American Type. My studies of American Indians confirm the fact that they have a large proportion of group I, and indicate that full-blooded American Indians are entirely group I. The assumption is obvious that the American Indians branched off or were isolated from the old-world peoples before either mutation took place. In North America they are now reduced to insignificant numbers, and it is hard to be sure of racial purity. In Latin America it is practically impossible to find any pure race, as twelve generations have now passed since the first Europeans arrived. These first arrivals nearly all married native women, and every degree of mixed blood is now found, with corresponding changes of blood group proportions. The Indians from Mexico give the nearest approach to the group distribution of the whites.

The interior of South America may afford some pure races of American aborigines, and they should by all means be studied. It is to be hoped also that blood group studies will soon be made of Eskimos and Patagonians.

The small amounts of A and B present in American Indians are in the relative proportions in which they are found in whites. Similarly, the small amounts of A and B found in Filipinos are in the relative proportions found in the surrounding Ethiopian and Maylayan peoples, indicating that full-blooded Filipinos would likewise all be group I. In other words, both of these races were isolated from the other peoples of the Eurasic continent before either mutation took place.

The Australian Type. The Australian aborigines show a rather large proportion of group I, indicating their early separation from the Eurasic continent. However, their frequencies p and q are such as to put them nearest to the European type. One hesitates to include them in the European type, however, because of their very low frequency of B.

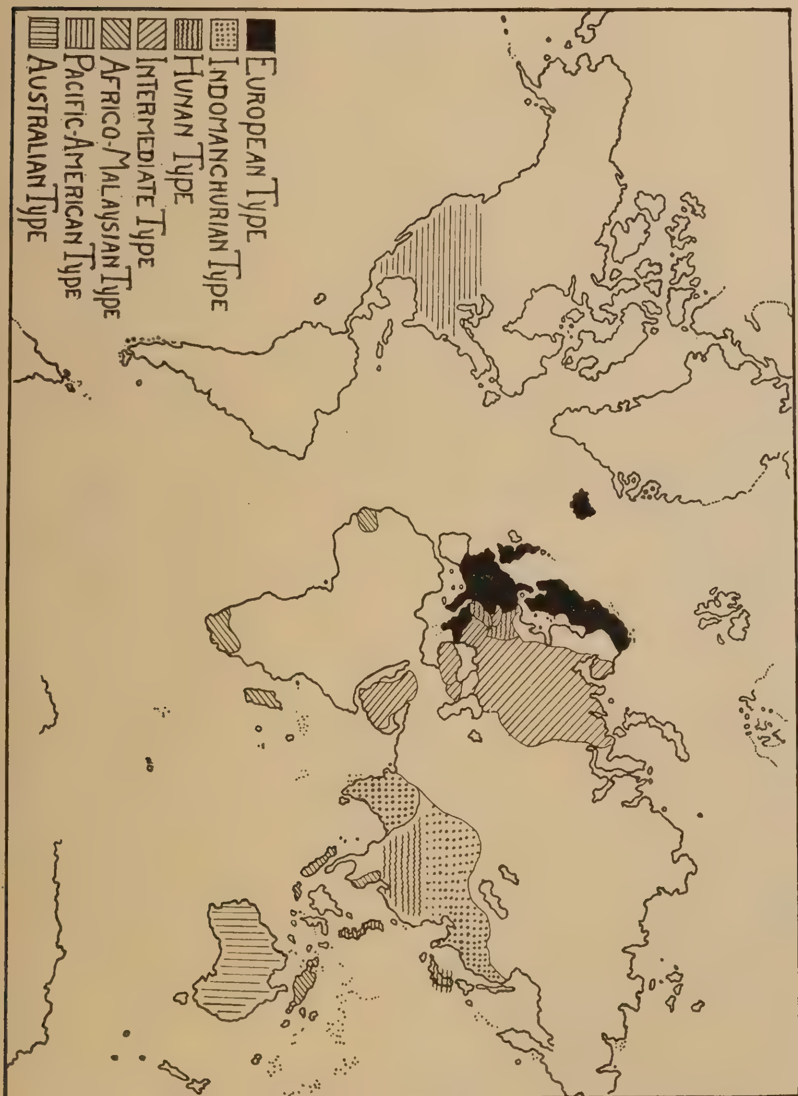

FIG. 1. Distribution of the seven types throughout the world.

Ottenberg included them in the Pacific American type, but their high frequency of A seems to preclude this. Possibly the Australians became separated after the appearance of A but before the appearance of B. On the other hand, the frequencies are such as to suggest an invasion by a race of the European type, possibly a race whose blood group proportions are as yet unstudied. A knowledge of the proportions of the groups in Dravidians would be of interest in this connection. In Pliocene times Australia was accessible on the north and west to primitive migrations both from India and Maylasia. It is to be regretted that it is too late to learn the group proportions of the Tasmanians. A further study of Australians, particularly those known to be full-bloods, is needed.

Figure 1 shows the distribution of the seven types throughout the world.

DISCUSSION

Hirszfeld and Hirszfeld considered their statistics to show that there was probably a double origin of the human race; a race arising in northern or central Europe, bearing the factor A, and a race arising in the Orient, possibly in India, bearing the factor B. Bais and Verhoef (1924b) favor this polygenetic origin of the human race, going so far as to suggest also a separate origin for the American Indians.

While there can be no doubt that A and B arose separately, in different regions, it does not seem necessary to postulate a double or triple origin of the human race to account for it. The facts can be as well explained on the assumption of a single origin of mankind. The blood group factors are due to only two mutations in a single gene, and differences in blood group proportions, while they may indicate something of racial relationships, are not such as to warrant the assumption of independent origins of mankind. The cradle of the race can not be learned from the blood group data alone.

Wherever man originated, there is no doubt that his original blood group formula was RR, that is, all group I. Certain races, such as the American Indians and perhaps the Filipinos and the Australian aborigines, became separated from the rest of mankind before mutations A or B took place. Migrations from this place of origin, and development under new environmental conditions, with the resulting genetic changes, can account for racial differences. The assumption of the dominant mutation A in Europe, and of B in India or the Orient, seems warranted.

The prevalence of B among the blacks on both sides of the Indian Ocean lends possible support to the hypothesis of a one-time Indo-African continent serving as the cradle of mankind. The sinking of this land would have caused B to spread both eastward and westward.

Although factor A decreases from Europe eastward, it never becomes rare, even in the most eastern peoples. B, on the other hand, becomes quite rare in extreme western peoples, q reaching as low as five or six per cent. Bais and Verhoef suggest that this may indicate that A is older than B. This is a possible explanation, agreeing with the assumption that B did not arise in Asia until after the American aborigines had become separated from the rest of mankind. It might also be explained, however, by considering that mutation A took place originally in more individuals than did mutation B, or by the assumption that the eastward migrations of European peoples were more extensive than were the westward migrations of Mongols, or yet again an independent Asiatic mutation of A may be postulated. The last is only to be accepted after all other possibilities have been exhausted.

As to the cause of the blood group mutations, we know nothing. Bernstein makes the rather naive suggestion that the eating of rice in the Orient may have caused mutation B. We do know, however, that the mutations are remarkably stable under rather extreme environmental influences.

Another use of the blood groups, from the anthropological standpoint, may be suggested here. It is possible to use the groups as an additional criterion in determining identical twins. If twins who are suspected of being identical should have different blood groups, they could not be univitelline twins.

Until much more extensive work is done on the peoples of Africa and the Orient, no very definite conclusions as to racial relationships may be drawn from the blood group data. Even then we can not be too cautious in our applications. The great need now is for the study of real races, not just nationalities. The data, however, merit close study by competent anthropologists. It is hoped that a logical presentation of the available facts, to serve as a groundwork, has been made in this paper.

TECHNIQUE

The blood was grouped by the method recommended by the National Research Council. This is as follows. Test sera of groups II and III

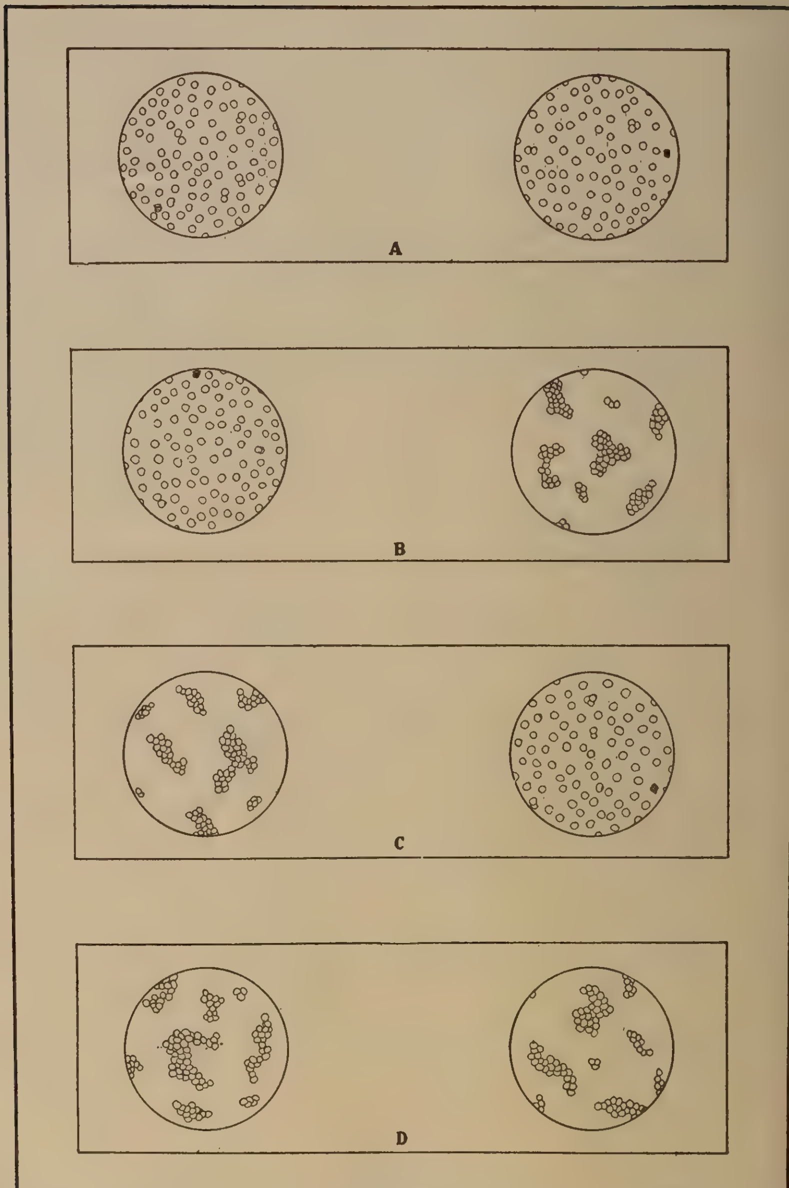

FIG. 2. Appearance of the red cells under the microscope in each of the four blood groups. Serum of group II on the left; serum of group III on the right. A, group I; B, group II; C, group III; D. group IV.

are used. A drop of each serum is placed on a slide, and into it is allowed to fall a drop of cell emulsion. The slide is tilted and rotated gently so that the cells are uniformly distributed; this is repeated every couple of minutes. A cover slip is placed on the mixture after two or three minutes of thorough mixing. The slides are examined under the microscope. At room temperature agglutination shows up plainly in from one to ten or fifteen minutes.

If neither test serum agglutinates the cells, the blood belongs to group I. If serum of group III agglutinates the cells, the blood belongs to group II. If the cells are agglutinated by group II serum, the blood belongs to group III. If both sera agglutinate the cells, the blood belongs to group IV.

Figure 2 shows the appearance of the cells under the microscope in each of the four groups.

A test serum must not only be shown to be of the correct group, but to be highly potent before it is taken into use. The test sera used in these investigations were obtained from the Washington University Medical School.

In the case of the Cherokee Indians, the epileptics, the feeble-minded, and the dementia praecox, and in most of the inheritance studies, the blood was obtained personally, by a prick in the end of the finger with a sterile needle, and was grouped within a few hours after taking. In the blood sent from a distance, the following method was found to be satisfactory in every way. For the suggestion of the use of formalin I am indebted to Prof. I. V. Shunk, bacteriologist at N. C. State College.

Small bacteriological tubes, $\frac{3}{8}$ by 3″, were filled with a solution made as follows: 1000 cc. distilled water, 8.5 g. NaCl, 1 g. Na, Citrate, 1 cc. formalin. The tubes filled with the solution were sterilized, then corked and sealed shut by dipping the corked ends into melted parafine. After the drop of blood was added to the tube at its destination, each tube was again sealed shut before being returned. In this way tubes sent to Malta, Holland, Mexico, Canada and the Pacific coast were returned safely with the agglutinophyllic capacity of the red cells unimpaired. Tests made showed that the agglutinophyllic capacity could be maintained at least several weeks by this method.

For the blood obtained personally, the same solution was used, with the omission of the formalin. Before testing any of the cells, they were always centrifuged to the bottom of the tubes, the supernatant solution pipetted off, and isotonic saline added. A 1–2% cell emulsion was used.

SUMMARY

1. A study of the blood groups of 200 families, involving 1095 individuals, is given, which, with the mathematical considerations of the mass data, indicates that the blood groups are inherited as a series of three multiple allelomorphs, not as two independent pairs of factors, as has long been supposed.

2. A detailed study of the group proportions of American Indians is given, indicating that full-blooded Indians are all group I, the occurrence of the other groups being due to white admixture.

3. Evidence is presented for the normal distribution of the groups in cases of insanity, epilepsy, and feeble-mindedness.

4. The group proportions of Maltans and Dutch are given for the first time, and additional data is presented on Americans and American negroes.

5. A classification of peoples, based on the frequencies of the three factors A, B, and R, is given.

6. The application of the blood group data to racial relationships is discussed.

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NEW DATA ON THE INCIDENCE OF THE SUPRACONDYLOID VARIATION

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That a correlation exists between the frequency of the supracondyloid variation and race has been shown by the recent studies of this subject in large groups of Whites,[1] Negroes[2] and American Indians;[3] the probability of such correlation has been remarked among the Japanese.[4] During the past summer 565 negroes were examined for the supracondyloid process and there was found but a single case (a male mulatto); this experience helps to confirm the earlier tentative conclusion of the rarity of the variation in the Negro. Also, the result of a study of1,000 humeri[5] of American Indians, among which no instance of the process occurred, will support Hrdlička's count recently published.[6] What the distribution is in other colored races awaits further investigation.

The incidence among Whites given by different authors, shows considerable variation. To some extent the lack of agreement can be accounted for by differences in the methods of calculation. For example, Testut has given the figure 1 per cent; but it is evident that the form of the variation now differentiated as a "tubercle" was counted as a "process" in his calculation; eliminating the former, the figure would fall to 0.6 per cent. Again, some authors count the number of processes found in a series of humeri; and others yet, only the number of subjects in a group having the process, whether it be present in one or both arms. The last has been my practice in examining the living. When, however, the method has been taken into account, it is evident that the results obtained in several investigations of the Whites are not the same. How is this to be explained? Earlier writers on supracondyloid process suggested that the differences in frequency might be characteristic of differences in stock: Gruber had found the incidence in Russians 2.7 per cent, Struthers claimed 2 per cent for the Scotch and Testut 1 per

[1]Terry, R. J. *Am. J. Phys. Anthrop.*, 1921, IV, 129. Pieper, Irene. *ibid.*, 1925, VIII, 169.

[2]Terry, R. J. *ibid.*, 1923, VI, 401. Hrdlička, A. *ibid.*, 1923, 405.

[3]Hrdlička, A. *loc. cit.*

[4]Aguila, P. *Arb. anat. Inst. Univ. Sendai*, 1924, H. X., 37.

[5]Terry, R. J. *Anat. Rec.*, 1923, XXVI, 171.

[6]Hrdlička, *loc. cit.*

cent for the French series he studied. A definite factor in determining the frequency of the variation in any group is that of inheritance, for the supracondyloid is an hereditary trait. Given a group derived from a community that is fixed the chance of finding a high incidence of the process is much greater than in a group taken from a place having a large floating population. Therefore it is to be expected that an old rural community will yield a higher incidence than a group of the same size from one of our large cities.

My further study of incidence was made possible by permission, generously granted,[7] to examine the inmates of several state prisons. The institutions visited were the Missouri State Prison at Jefferson City, housing a large population, the Wisconsin State Prison in Waupun, the two Illinois State Prisons in Joliet and the one in Chester. The conditions for studies of this kind in prisons is nearly ideal: the kind of subject respecting race and sex is present in large numbers; examinations can be made expeditiously, several kinds of records are available, cases may be reexamined from time to time. At Jefferson City the prison population examined is largely of English, Scotch, and Irish descent; at Joliet it was about equally divided between this element and another of German, Hungarian, Polish and Scandinavian derivation. The Jefferson City Penitentiary population is regarded by prison officers as mixed urban and rural with a very large rural element; the Joliet Prison population as chiefly urban. The constitution of the groups as to birth place in country or city is not shown in the records; the characterization given therefore is not final.

The method of examining was the same in every case: palpation of both arms at the site of the supracondyloid process. The experience gotten by the examination of several thousand arms reduces the chance of error to almost zero. The feel of the process is unmistakable. Nevertheless, on the discovery of a spur the whole elbow region was carefully explored for evidence of possible trauma and the subject questioned relative to injury or disease in the region. A recorder took the number and age of the inmate at the beginning of each examination and marked the result at its close. There was no selection; the ex-

[7]The writer acknowledges his deep appreciation of the help received in carrying on this survey through the courtesy of Chancellor Hadley of Washington University; Hon. Sam Baker, Governor of Missouri; Hon. Len Small, Governor of Illinois, and Hon. John J. Blaine, Governor of Wisconsin. For permission to collect data in the several prisons he is grateful to the Department of Penal Institutions of Missouri, the State Board of Control of Wisconsin and the Department of Public Welfare of Illinois; for aid in making the examinations and for many courtesies he extends to the wardens and other officers his best thanks.

amination which was made by myself, proceeded from shop to shop or from cell to cell, every man undergoing the test.

I have mentioned the different results obtained in the calculations of incidence of whites and one probable source of discrepancy, viz., through differences in the methods employed. In order to have a control or basis for comparison for the calculations now to be stated the incidence of a group of known composition derived by the method of examination employed in the present test, has been shown. In a series of 658 white males, composed of the two groups previously reported by my pupil Miss Pieper[8] and myself,[9] seven persons having the process were discovered (1.06 per cent) by the method to which I have just referred: examination of the living.

The distribution and incidence of supracondyloids in the four prisons are shown in Table I.

TABLE I.—THE SUPRACONDYLOID PROCESS IN MALE WHITES

Institution	Number of inmates examined	Number of inmates having supracondyloid process	Percentage of inmates having process
Missouri State Prison.	1000	28	2.8
Wisconsin State Prison.	574	5	0.87
Illinois State Prison—Joliet. .	1000	8	0.8
Illinois State Prison—Chester	662	3	0.5
All Prisons.	3236	44	1.36

Compared with the frequency in the control series the incidence in the combined prison groups is somewhat higher; it is evident that the distribution is different in the four prisons and that the higher percentage is attributable to one institution. If the Missouri State Prison be excluded, then the average of the remaining three falls to 0.71 per cent. Thus, after taking strict precautions as to method of examination and choice of material comparable in race and sex and age, it appears that the large groups in four institutions present differences in the incidence of supracondyloids. What are the influences at the source of these discrepancies?

Tables II and III present certain data collected from the prison records regarding the supracondyloids found in the Illinois prisons at Joliet and the Missouri Prison.

The data now available permit a comparison on several points of the groups examined in the prisons of Jefferson City and Joliet.

Age. Previous observations on age of subjects having the supracondyloid process include fetal life and every decade from birth to 70 years. The chance of an apparent correlation existing between age and

[8]Pieper. *loc. cit.*
[9]Terry. *loc. cit.* No. 1.

Table II.—Illinois State Prison—Joliet

Six inmates in 1,000 having the supracondyloid process

No.	Age years	Stock	Occupation	Offence	Process rt.	l.
1	29	Hungarian	Barber	Larceny	+	o
2	28	English	Press man	Robbery	+	+
3	27	Polish	Musician	Larceny	o	+
4	22	English	Laborer	Larceny	+	o
5	32	English	Freight checker	Larceny	o	+
6	30	German	Farmer	Forgery	o	+
7	29	English	Boiler maker	Larceny	+	o
8	43	German	Millwright	Forgery	+	o

Table III.—Missouri State Prison

Twenty-eight inmates in 1,000 having the supracondyloid process

No.	Age years	Stock	Occupation	Offense	Process rt.	l.
1	27	Irish	Cook	Robbery	+	+
2	32	Irish	Baker	Robbery	+	o
3	27	French	Teamster	Burglary	o	+
4	21	English	Farmer	Burglary	+	+
5	24	English	Mechanic	Robbery	o	+
6	31	English	Laborer	Manslaughter	o	+
7	62	English	Miner	Murder	o	+
8	36	Irish	Painter	Larceny	+	o
9	35	English	Baker	Larceny	+	o
10	24	German	Carpenter	Murder	+	o
11	26	English	Laborer	Rape	+	o
12	27	Irish	Waiter	Rape	o	+
13	51	French	Farmer	Murder	o	+
14	23	English	Mechanic	Robbery	o	+
15	38	English	Boiler maker	Robbery	+	+
16	38	English	Farmer	Larceny	+	o
17	43	German	Laborer	Robbery	+	+
18	27	English	Laundryman	Burglary	o	+
19	54	English	Miner	Murder	+	o
20	37	English	Tobacco worker	Robbery	+	+
21	22	English	Blacksmith	Robbery	+	o
22	21	English	Farmer	Volstead	+	o
23	19	English	Laborer	Burglary	o	+
24	25	English	Laundryman	Robbery	+	o
25	27	English	Laborer	Burglary	o	+
26	48	English	Stable manager	Murder	o	+
27	19	English	Chauffer	Robbery	o	+
28	26	English	Boiler maker	Burglary	+	o

incidence of the process would depend upon such possible circumstances as fracture of the process and loss by absorption in older persons; failure to recognize the spur by palpation because of its incomplete ossification in young subjects, etc. No correlation was discovered. The proportion of supracondyloids of a given age to the whole group of supracondyloids was comparable to the proportion of the group of inmates of the same age to the total group. The decade in which the largest number of supracondyloids falls in both Joliet and Missouri is 20–30, the same decade to which the largest number of inmates of the two institutions belong. At Jefferson City where the supracondyloid

group is large the supracondyloids of the third decade form 50 per cent of the total supracondyloids, and the group of third decade inmates forms 47 per cent of the total group of inmates in this institution.

Stock. The records of the Joliet prisons give the birth place of parents (by states of the United States, by countries in Europe). Records of the Missouri Prison do not show nativity of parents; the name of the inmate is the only record indicative of stock. It appears that 88 per cent of the total group examined in the Missouri Prison have English, Scotch and Irish names; the remaining 12 per cent have German, Hungarian, Polish, Italian and French names and a few of other nationalities. In contrast, the group studied in Joliet includes approximately equal elements of those on the one hand having English, Scotch and Irish names, and on the other those with German, Hungarian, Polish, Scandinavian, Italian and French names together with a few names representative of other countries. The distribution of stocks in the supracondyloid group is almost exactly the same as is the distribution of stocks in the total group. In Jefferson City 90 per cent of the supracondyloids had English, Scotch and Irish names; in Joliet 50 per cent were of these stocks.

Occupation. The records show a large variety of occupations which had been pursued by the inmates of both prisons. Occupations represented by the groups of supracondyloids are also distributed through a considerable range as shown in the tables. Of the total number of cases only 6 are recorded as laborers and 23 as workers in occupations requiring manual skill or intelligence; 8 are mechanics of some kind and 14 others have occupations calling for hard muscular exertion.

Offence. Between 60 and 70 per cent of all offences represented by the two groups examined were made up by larceny, robbery and burglary; in the supracondyloid groups these offences reached 60 per cent in the Missouri Prison and 75 per cent in the Illinois Penitentiary.

In reference to the above data, the only significant difference between the groups examined in the two prisons is in the stocks: a preponderance of English, Scotch and Irish in Jefferson City; about equal numbers of inmates of that derivation and of German, Hungarian, Polish and Scandinavian origin in Joliet. As stated, however, the proportions by stock in the supracondyloid groups were distributed in the two prisons as were the stocks in the total groups of inmates. The comparison of these two groups reveals no correlation between the incidence of the process and some particular stock.

The high incidence of the supracondyloid process in the Missouri Prison group has not been explained. Investigation is in progress to collect the family histories of the supracondyloids and to determine if possible the incidence of this variation in the communities in which the subjects were born. It is probable as I have stated above that the incidence will be higher in a group derived from rural districts with relatively fixed populations than in a group from a city having a large floating population.

LITERATURE

THE AMERICAN INDIANS

CAYAPA INDIANS OF ECUADOR. Parts I and II. By Barrett (S. A.)—*Indian Notes and Monographs*, (Mus. of the Amer. Indian, N. Y.). 1925, No. 40, 12mo, 476 pp., numerous illustr's.

The Cayapa Indians live "at present almost wholly on the main and tributary streams of the Rio Cayapas, one of the large rivers of the northwestern part of the province of Esmeraldas, Ecuador, and about ninety miles in a direct line north of the equator. Their territory is within comparatively easy reach of the ocean, which almost all visit at least once a year." Their previous home is said to have been in the mountains near Ibarra. The present studies were made by the author between July 1908 and April 1909. They are essentially ethnographical but the report includes numerous photos of the people and the second volume is supplemented by a chapter on Physical Anthropology in which are given the principal measurements on 19 adult males and 21 adult females, besides those on a number of younger subjects. The people show a short stature (m. 155, f. 146 cm.), brachycephaly (m. 83.6, f. 86.8), and a rather rounded face. The body is light reddish-brown and may have been influenced by the nearly constantly overcast skies in this region. In their physiognomy and general physical characteristics these Indians connect, it appears to the reviewer, with the Maya-Tule-Yunga type of further north and south.

INDIANS OF SURINAM. By Verrill (A. Hyatt) — *Indian Notes*, 1925, II, No. 4, 309–313 (Mus. of the Am. Indian, N. Y.).

The Indians of Surinam recently visited by the writer "are decreasing very rapidly in numbers and have practically abandoned all primitive arts and customs. In the colony there are now probably not more than one thousand Indians, comprising only five tribes. These are the Carib, Arawak, Warrau, Trio, and Akawoia. Unlike British Guiana, the hinterland of Surinam is almost totally uninhabited, the Bush negroes or Djoekas, extending barely one hundred and fifty miles up the rivers, and the Indians being confined to the coastal district and the Brazilian border. Undoubtedly this dearth of inhabitants in the interior is due to the relentless warfare waged for many years against the Bush negroes, during which the Indian allies of the whites were wiped out by the black men, who exceeded them in numbers, whereas in British Guiana the Indians were more numerous than the Djoekas and exterminated the latter. The coastal tribes (whose farthest villages are barely sixty miles from the sea) are wholly Arawak, Carib and Warrau. Of these the Carib are the most numerous and have been influenced the least by contact with whites and negroes. Few of the Arawak retain anything of their primitive ways, and the Warrau even less. Among the Carib there are many of pure blood, with a fairly small proportion whose

blood is mixed with negro, Chinese, Javanese or European. Among the Arawak the mixed-bloods exceed those of pure Indian descent. In many districts also the Arawak and Carib have mixed and the few primitive customs preserved are in no way typical of either tribe . . . No governmental supervision or protection of the Indian exists as in British Guiana, with the result that the tribes are at the mercy of whites, blacks and others. Within the last five years the Indians have decreased fully fifty per cent, and within a few years more they will completely disappear as a distinct people."

EVOLUTION. AMERICAN POPULATION

I Believe in God and Evolution. By Keen (William W.)—4th ed., 109 pp., 12mo, 1925, Phila., (Lippincott Co. $1.25).

This is one of the smallest but most readable, assimilable and pleasing popular treatises on human evolution, and on the entire compatibility of a conviction in this process with a candid, all-pervading faith in the Creator.

The well-known author deals with the question in a scientific yet simple and lucid way, from the point of view essentially of the medical man and anatomist. The scope of the little volume will best be seen from the headings of sections which are: Operations on the Brain; Human and Animal Skeletons; The Heart; Liver and Ductless Glands; Thyroid Gland; Sympathetic System; Ancestral Vestiges; Identical Diseases; Cellular Origin of Life; Embryonic Deformities; Heredity; Influence of Emotions; Evidence from Fossil Man; The Message of Plants; Sexuality in Plants, Animals and Man; Evolution of Culture and Civilization.

Some of the chapters, particularly that on fossil man need strengthening, even for a popular presentation; but as a whole the book may be safely and warmly recommended to all those who seek a thoroughly wholesome and absorbingly interesting hour or two on human evolution.

Os Indios Parintintin do Rio Madeira. By Nimuendajú (Curt)—*J. Soc. des Américanistes de Paris*, XVI, 1924, n.s., 201–278.

The author presents data, general and somatological, on this little known Brazilian people (known also as the 'Kawahíb'). He deals among many other subjects briefly with the location, number, history and somatology of the tribe. From the very limited anthropometric data it appears that, though well built these Indians are of rather small stature (22 males 160.6; 11 fem. 146.4 cm.). There are no other measurements but good descriptive notes.

Notes d'Anthropologie sud-Américaine. By ten Kate (H.)—*J. Soc. Améric.* Paris, XVI, 1924, 183–193.

Dr. ten Kate who, fortunately, is still active, gives in this paper measurements and notes on eight South American Indian crania—one Carib, two Akawoi, one Arowak, three Goajiros, and one (a young female) Lengua. The data will be serviceable for future comparisons.

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THE ANGLE OF GAIT IN WOMEN

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Little if any mention has been made of the angle of gait in women in the wide literature dealing with the lower extremities. The act of walking has been analyzed in detail by Otto Fischer 1900, in "Der Gang des Menschen," but few observations have been made on human gait. The angle of gait of a selected group of men has been determined only by Dougan '24.

Block '96 described a method for taking plaster casts from impressions made by subjects who had walked over a heavily sanded platform. He chose a right and a left imprint at random. He stated that these imprints reveal the parts of the plantar surface of the foot which are affected as a result of arthritis, paralysis, diseases of the central nervous system, fractures, etc. These casts, he claimed, could be used for premature diagnosis, "diagnostic hatif," of certain doubtful lesions, and for the differentiation of various types of limps, but he gave no description of the casts of either the abnormal or normal subjects. It is not clear to me what Block meant by "diagnostic hatif" unless it is that by means of these imprints he could diagnose these diseases before the symptoms manifested themselves.

Judging from observations, it hardly seems plausible that one impression of each foot, chosen at random, would be sufficient to give an idea of the gait of a "normal" individual, for Dougan and I found that the variation in the angle of gait in successive steps in the same subject, is considerable. As my tables show, two successive steps rarely have the same angle of gait, the differences being as great as fourteen degrees.

Bradford '97 divided human gait into "the walk and the run." Walk he then subdivided into "upright gait," one which is used on the level, characterized by the erect posture of the trunk, and the firm planting of the heel of the forward leg on the ground, common among shoe-wearing people. The rear of the foot is mostly used in this type of gait.

The second type of walk he ascribes to "barefooted individuals, where the weight of the body in propulsion falls on the forepart of the foot, and the heel is little used." This gait, he says, is also characteristic of young children, of adults when snow-shoeing or when walking on slippery places, or up a sharp ascent. He states that "a combination of both gaits is seen in strong and active walking" and adds that "variations in walking are dependent upon differences in the relative strength of the muscles brought into action." Merely from watching pedestrians he concluded that gait varies according to age, size and strength of the individual and rapidity of gait. "Toeing-in, more common in barefooted people" is said to be "partly due to the inward divergence of the first metatarsal, a vestige of the earlier arboreal traits." From the examination of photographs of barefooted and mocassin-wearing people, such as Turks, Dalmatians, Egyptians, Somalis, Congo Negroes etc., he concluded that "the divergence is less in individuals where the muscles of the front of the foot have been developed by active use of the free, unrestricted foot, than in people who have worn shoes since early childhood. . . . . Parallelism of feet is the rule in barefooted people, due to the fact that the muscles of the foot and leg are sufficiently strong to enable them to dispense with the broader base, afforded by divergent feet." In shoe-wearing people an angle of divergence is the rule, except in children. Bradford concluded that "it is difficult to determine what degree of divergence is to be regarded in shoe-wearing people as normal," and from a series of observations made on the street, from the top of omnibuses and high buildings, concluded that the angle of divergence is greater in the inhabitants of London, than of Chicago, New York, Boston or Cambridge, and is least in Holland, because "their feet in childhood are either bare or unconfined in sabots."

He declared 45 degrees to be a normal angle in standing, 30 degrees for a leisurely gait and 10 degrees for a fast walk. For growing children, before puberty, the angle is said to be less, greater divergence being due to an external rotation at the hip-joint. Bradford concluded with this sentence: "Parents are frequently anxious that children should be trained to walk with an exaggerated angle of divergence under the impression that it is graceful or correct; but the fact is that foot prints in a normal active walk are parallel, and the stronger the gait, the straighter the walk."

These statements are very interesting, but not in accord with those made by Hoffmann, 1905, who examined 186 Filipinos. By means of imprints on smoothed paper and plaster casts, Hoffman was surprised to

find that the straight gait was not as common as he had supposed it would be amongst non-shoe-wearing individuals.

In my own series, one subject, No. 67, particularly attracted my attention because she showed exceptionally strong feet, giving a total deformation, under body weight of only 1.24 cm. for both feet. Yet her angle of gait showed variations from 2.6 degrees to 11.7 degrees, with an average angle of 7.24 degrees for nine steps. This was practically the same angle as the average angle of gait of the 150 women in my series. On being questioned it was found that she is in the habit of going barefooted, did so when a child, and still enjoys it for approximately three months of the year. In spite of this fact, her angle of gait is somewhat larger than that of her shoe-wearing college mates although her feet appear so much stronger. This is the only case of an individual who had gone barefooted to quite an extent, but it raises the question whether a parallel gait really is an evidence of strength of foot.

It is not clear why Bradford chose 30 degrees for the angle of divergence of leisurely walking. In my series of 150 adults, only four cases showed an average angle of gait lying between fourteen and sixteen degrees, which makes a divergence of approximately 30 degrees. Moreover, if a divergence of thirty degrees is the normal angle in leisurely walking then how can it be true that "footprints in a normal active walk are parallel and the stronger the gait, the straighter the walk?"

Bradford, 1899, also declared that exaggerated toeing-out, is common in corpulent persons, and during walking down an incline. "The stronger the foot and the stronger the gait, the less the angle of divergence and the more near to the central line and a horizontal plane the foot moves. In shoe-wearing people in whom the action of the front of the foot is weakened, a slight amount of toeing out broadens the base of support. A slight amount of divergence is seen among barefooted people, owing to the attachment of the psoas and iliacus muscles to the inner surface of the femur, when the thigh is swung forward, it would turn out slightly. This is checked in the strong gait in which the muscles of the front of the foot are actively and firmly used." I do not feel qualified to analyze the angle of gait but for very obvious reasons, I doubt the correctness of this explanation.

Hoffmann, examined 186 Filipinos at the Louisiana Exposition, taking plaster-casts of their feet during and without weight-bearing, and also taking foot-prints on smoked paper of the plantar, weight-bearing areas. He stated that he noted whether the gait was straight or everted, and the degree of eversion. Just how this was determined is not stated. Hoffmann did not note one case which showed symptoms of weakness.

His estimate of the height of the arch was determined by the imprint method, i. e. the broader the imprint of the instep, the lower the arch. This is a rather misleading method, because marked muscular development might give an impression of a low arch. However, Hoffmann claimed this not to be the case and stated that he compared these imprints with the plaster casts.

Dougan made determinations on 239 males including university and high school students. He obtained the foot prints as I did but used a platform only 18 ft. instead of 28 ft. long. This platform was covered with carbon under heavy manila paper. Each subject walked over this with gaiters provided with specially placed hobnails, a new stretch of paper being used for each subject. Each individual took from ten to twelve steps on the level and both ends of the platform sloped gradually to the floor in order that the footsteps might assume an angle more nearly characteristic of the individual before the first impression was taken, by obviating the necessity of taking an abrupt upward step. Gaiters of four sizes and provided with specially placed low flat hobnails were used.

To insure a natural walk the subject was not told the purpose of the experiment, but after becoming accustomed to the gaiters, was merely asked to walk leisurely across the platform. I feel reasonably certain that this type of footwear did not alter the average angle of gait of the individual materially. In fact, footwear of this type would be far more apt to permit a normal angle of gait than a high-heeled shoe, which is often worn, or even no heel at all. To what extent these things affect the angle of gait remains a matter for future determination.

The first imprint was discarded in the calculations. The measurements of the angle were determined in the following manner. A line was drawn through the middle of the impression made by a nail at the back and middle part of the heel and one in the middle of the sole. This line was extended backward until it intersected a longitudinal line drawn through the middle of the paper on which the individual walked. The number of degrees between the two lines was then determined for each step by means of a protractor, and the average designated as the angle of gait.

The length and width of the foot and the height of the arch were determined by means of the pedometer shown in Fig. 1. It consisted of the horizontal board 1, 30 cm. wide and 45 cm. long. At right angles to the end of this was erected the board 2, which was 27 cm. high. At the middle of the horizontal board was a vertical partition 3, so that one side could be used for measuring one foot and the other for the second. This

partition which was 16.5 cms. high, carried a steel scale 7, graduated in millimeters and movable in a vertical and horizontal direction. A movable steel rod 6, was used as an indicator in measuring the height of the arch. This was adjustable in two planes. The length of the foot was obtained by a sliding indicator 4, attached to a centimeter scale placed on the central vertical board. The width of the foot was recorded by means of a sliding pointer 5, also attached to a scale and moving flush with the base of the pedometer. The heels of the feet were placed against the transverse riser 2.

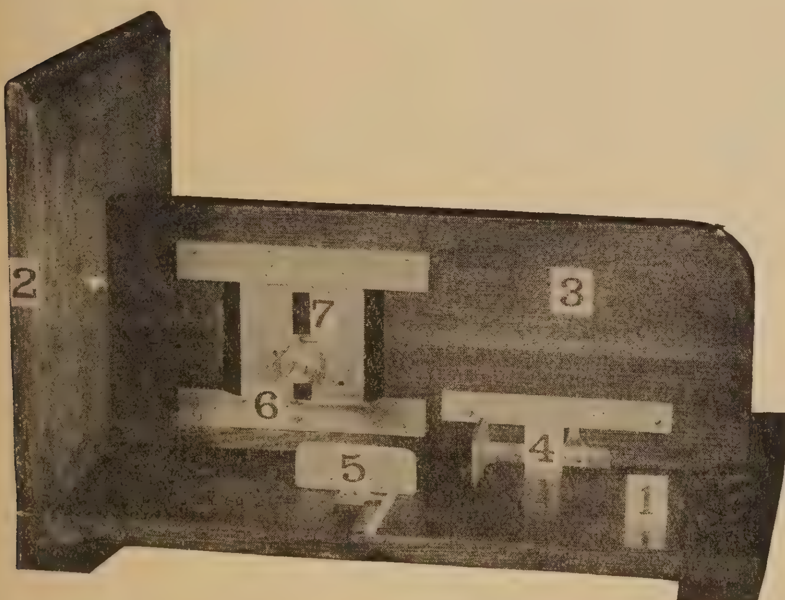

Fig. 1

Through the kindness of Miss Bunting I was able to make my determinations on 150 women, chosen at random, from the Stanford University gymnasium classes. They belonged mainly in the freshman and sophomore years.

The linear measurements of the feet were taken while the person was seated and also while standing on one foot. They were permitted to balance themselves slightly by means of the back of a chair if necessary. To assure myself that I was dealing only with normal women each individual was asked whether she had suffered disabilities of the lower

extremities. Some complaints were made by a few, but they were of minor consequence, and judged to be of no significance in the experiment.

Significance was given to one-tenth of a centimeter in the measurements which were taken.

The distance from the base to the arch over the calcaneonavicular articulation was taken as the height of arch. This point was used because it was regarded as more accurate than the tubercle of the navicular, for, an examination of 50 naviculars in the dry state showed that the tubercles varied greatly in size and shape. "Heiner's line" was not used, because, in measuring 49 tibiae in the dry state, the distance from the medial intercondyloid tubercle to the tip of the medial malleolus was found to bear no direct relationship to the length of the medial malleolus, as Figure 2 shows. Hence an inaccurate measure of the height of arch would be obtained by the use of it.

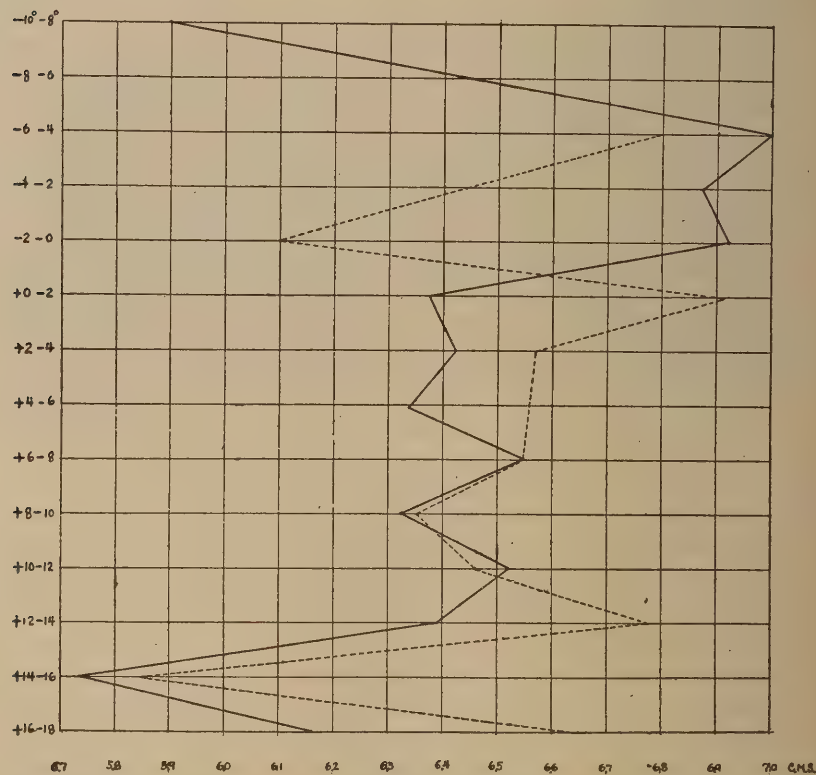

Fig. 2

In considering the subject of the angle of gait in women, I have endeavored to determine whether there is a normal angle of gait and if so, what it is, whether the average angle of gait might be termed the normal angle, and what factors might influence it. In the extensive literature dealing with the subject of the normal foot from an anatomical standpoint, weak foot, flat foot and the many other correlated subjects, I have been unable to find any such established norm.

I found only two statements for men, Bradford, '97 giving 15° as the normal angle, and Dougan finding it approximately 6.6°.

Forty-two individuals were asked whether they had been instructed in a specific manner of walking, and if so, whether they had heeded these instructions, and had thought of them while walking across the platform. Thirty-two, who recalled such instructions stated that they were told that the feet must be placed straight ahead and parallel. Of these 28 were conscious of trying to do so occasionally only, and their average angle of gait was 7.4°. It varied from 0.5° to 15.7°. The average angle of gait of those who stated that they never thought of the instructions, was only 5.8°. The average angle of the uninstructed individuals was 7.9°, varying from 3.3° to 16.8°. Not one of the 42 thought of these instructions while crossing the platform. These results not only suggest that we are not apt to habitually walk the way we are told to, but rather as anatomical or other factors determine. This is especially likely since Dougan's determinations revealed a marked difference between the angles of gait on the two sides in the same individual and also an inconstancy of the angle on the same side during successive steps. Instructions could hardly affect one leg more than the other.

Dougan found only 6 individuals with the same angle of gait on both sides; I found none in women and only five of them showed a difference less than one degree. Dougan's observations showed one person who walked without deflection. I found three with an average negative angle, although the right foot in these three women was the only one to toe in. All the imprints were negative on one side in 2 persons only. The greatest angle of deflection on the right was 19°, on the left 21°. Dougan found a maximum of 20.3° on the right and 16.5° on the left. The largest negative angle was 7.5° on the right, 5.5° on the left. Dougan found it to be 5.8° on the right, 8.2° on the left. The maximum amount of fluctuation between two successive steps was eleven degrees. Where all the angles on the one side were positive, the greatest range in the angle of gait was 13.2°, where all were negative, the greatest range was only 4.5°, and where both positive and negative angles were found on the same side, the greatest range was 14.5°. The average angle of gait

for the right foot was 6.5°, for the left 7.0°, giving an average for both feet of 6.8°. Dougan determined the average angle of gait to be 7.2° for the right foot, 5.8° for the left, with an average for both of 6.5°. He accounted for the larger deflection of the right foot by the fact "that most persons depend more upon the use of the right leg for the maintenance of body equilibrium." However, it may be an expression of better muscular development of the right leg, in consequence of greater use also for other purposes than the maintenance of equilibrium, but that a greater angle of gait is due to greater muscular development is not in accord with some of my findings in regard to deformation. (Table 10) Moreover, since the average positive angle of gait in women was found greater on the left side, Dougan's suggestion would imply that they use the left leg more than the right.

This crossed correspondence in averages between women and men is probably of little significance. It may be a chance result of a small series of cases and must not be taken as an indication of a sexual difference. However, the closeness in agreement of the averages for the male and female as determined by Dougan and myself, tends to show that we are dealing with some more inherent cause than teaching.

Toeing-in occurred 7 times on the right and 2 times on the left side in my series of 150 cases and 3 times on each side in Dougan's 126. None of my series toed in on both sides, and only one of Dougan's did so.

Dougan's records (unpublished) show that 5 out of 103 high school lads toed in on the right and 10 on the left, two persons toeing in on both sides. Toeing-in on one side or the other occurred in 15 per cent of these high school lads, in 6 per cent of university men and in 5 per cent of university women. It occurred exactly as often on the two sides in these 379 cases and was present as often in 103 high school boys as in the 276 university men and women in Dougan's and my series.

TABLE 1.

Average Measurements in Centimeters

	Seated		Standing on one foot	
	Right	Left	Right	Left
Height of arch	6.4	6.5	6.1	6.5
Length of foot	23.7	23.6	24.0	24.0
Width of foot	8.2	8.1	8.5	8.5

Table 1 shows the average height of the right and left arches to be practically the same in the sitting posture. The length and width of the right foot are a trifle larger than those of the left. This is contrary to the findings of Dunn (1923), but when standing, the averages of the width and those of the length of the left foot become greater than those of the right. The deformation in the case of the right foot is 4.6%, in the left

6.2%. This suggests that the muscles and tendons of the right foot are stronger than those of the left, probably because of greater use.

As shown in Table 2 the person with the greatest angle of gait has not necessarily the lowest arch, nor the one with no angle the highest arch. Nor is there a steady decrease in the height of arch as the angle of gait becomes greater. These conclusions are drawn from persons with angles of gait from 0°–14°, which are the most numerous. This, to be sure, does not imply that toeing-out does not place more strain upon the arch of the foot or that toeing-in will of itself raise a low arch.

TABLE 2.

HEIGHT OF ARCH IN CENTIMETERS AND ANGLE OF GAIT IN DEGREES

Angles of gait in degrees	No. of persons Right	Left	Average height of arch in centimeters Right	Left
—10 to —8	1	0	5.9	
—8 " —6	0	0		
—6 " —4	1	1	7.03	6.68
—4 " —2	4	0	6.77	
—2 " 0	2	1	6.92	6.1
0 " 2	11	13	6.28	6.92
2 " 4	18	19	6.43	6.52
4 " 6	34	31	6.34	6.52
6 " 8	24	27	6.55	6.55
8 " 10	20	20	6.33	6.35
10 " 12	22	21	6.52	6.47
12 " 14	5	11	6.39	6.78
14 " 16	6	4	5.74	5.85
16 " 18	2	2	6.17	6.65
	150	150		

Table 2 also shows that the average angle of gait in two-thirds (99) of these 150 women, lay between plus four and plus twelve degrees.

The height of arch seems to be far less variable, for 132 of these women had a height of arch lying between 5.6 and 7.2 cms. inclusive.

TABLE 3.

HEIGHT OF ARCH IN CENTIMETERS AND AVERAGE PERCENTAGE OF DEPRESSION

Height	No. of Cases Right	Left	Average drop in centimeters Right	Left	Percentage drop Right	Left
5.2–5.4	3	2	0.16	0.37	3.0%	6.9%
5.4–5.6	7	7	0.28	0.52	5.0%	9.4%
5.6–5.8	10	6	0.19	0.50	3.3%	8.7%
5.8–6.0	18	15	0.29	0.54	4.9%	9.1%
6.0–6.2	21	14	0.38	0.43	4.5%	7. %
6.2–6.4	28	24	0.32	0.53	5.0%	8.4%
6.4–6.6	17	27	0.38	0.58	5.8%	8.9%
6.6–6.8	8	14	0.42	0.56	6.2%	8.3%
6.8–7.0	17	14	0.40	0.53	5.7%	6.6%
7.0–7.2	8	14	0.40	0.53	5.6%	7.4%
7.2–7.4	6	3	0.40	0.92	6.3%	12.6%
7.4–7.6	4	6	0.48	0.80	6.4%	10.9%
7.6–7.8	2	3	0.72	1.00	9.2%	12.9%
7.8–8.0	1	1	0.43	0.69	5.4%	8.5%
	150	150				

This is not what one should expect if a direct relation between height of arch and angle of gait existed. The existence of differences between the height of arch in the same person is shown by the measurements and becomes more evident by the distribution on the two sides of the body as shown in Table 3.

Table 3 shows the height of arch and the amount and the per cent of drop when approximately all the body weight is placed on one foot. From this it is evident that the per cent of drop in cases with arches from 5.4 cm. to 7.6 cm. is not greater in low than in high arches. Neither is there any correlation between the height of the arch and the strength, as indicated by per cent of drop of the arch when the body weight is placed upon one foot. This fact is brought out strikingly by the graph in Figure 3. We can therefore conclude that a high arch is not necessarily strong nor a low arch weak. This was stated also by Hoffmann (1907), Feiss (1909), Weed (1912), Whitman (1917) and Dunn (1923).

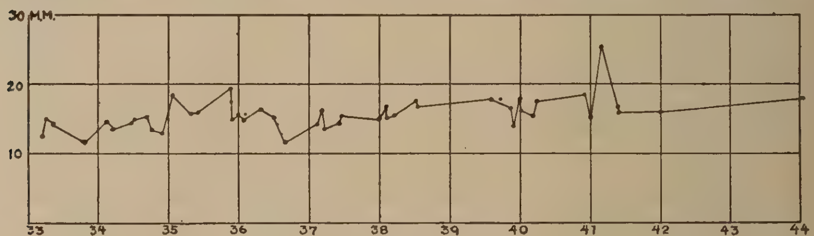

Fig. 3

In 5 persons only did I observe an arch strong enough not to yield when the body weight was borne on one foot. The height of arch in these persons and the angles of gait are given in Table 4. It is interesting that the highest arches did not occur in pairs and that five of them were found in the right foot. It is possible that this finds its explanation in use, for it suggests right leggedness, although with right handedness one should, to be sure, expect left leggedness. Upon inquiry, I find that three of these five young women are right handed, one is left handed and the other has some tendency that way.

TABLE 4.

Serial number	Height of arch in centimeters		Average angle of gait	
	Seated	Standing	Right	Left
4	7.32	7.41	7.84°	7.70°
49	6.28	6.30	6.96°	6.65°
67	5.89	5.90	5.81°	4.34°
134	5.76	6.00	5.94°	4.02°
36	(left) 6.12	6.15	6.15°	7.12°

Table 5 indicates no tendency for the shorter individual to have a lesser angle of gait, yet the center of gravity is lower in them and they have relatively broader pelves and bases of support. Fourteen women 67 inches high, for example, showed an angle of 4.7° on the right, but one of 6.5° on the left. That there is no direct relation between angle of gait and height is best shown by this lack of correspondence between the angles on the two sides of the body.

TABLE 5.

RELATION OF STANDING HEIGHT OF INDIVIDUAL TO ANGLE OF GAIT

Height in inches	Number of cases	Average angle of gait in degrees Right	Left	Average of both sides
58	1	9.8	12.9	11.3
59	1	9.7	12.7	11.2
60	6	7.1	7.1	7.1
61	12	6.2	7.4	6.8
62	19	7.9	8.8	8.3
63	31	6.2	6.4	6.3
64	21	6.7	7.2	6.9
65	17	6.7	6.4	6.5
66	18	6.2	6.7	6.4
67	14	4.7	6.5	5.6
68	5	7.7	6.2	6.9

In Table 6, the angles of gait and length of foot are given. In all persons having angles of gait from 0° to 14°, there is no indication of reduction in the angle with increase in the length or width of foot. Since an increase in the length or width of the foot necessarily increases the base, and hence also increases stability, this is rather surprising.

The average length of foot in these women was 23.6 cm. and the average width 8.2 cm. The respective ranges lay between 20 cm. and 26.5 cm. for length and 7 cm. and 10.5 cm. for width.

TABLE 6.

RELATION OF ANGLE OF GAIT TO LENGTH AND WIDTH OF FOOT

Angle of gait in degrees	Average length in centimeters Right	Left	Average width in centimeters Right	Left
—10 to —8	22.60		7.80	
—8 " —6				
—6 " —4	25.16	23.10	8.80	8.10
—4 " —2	24.23		9.08	
—2 " 0	24.77	23.10	8.45	8.25
0 " 2	23.47	23.81	8.07	8.18
2 " 4	23.74	23.98	8.40	8.10
4 " 6	23.84	23.79	8.11	8.08
6 " 8	23.65	23.65	8.44	8.17
8 " 10	23.71	23.71	7.97	8.12
10 " 12	23.54	22.96	8.20	8.10
12 " 14	23.30	23.19	7.65	8.36
14 " 16	23.42	23.56	8.25	7.97
16 " 18	22.50	24.17	8.10	8.17

Bradford pointed out that "an exaggerated toeing-out of the feet" is characteristic of corpulent persons. Table 7 shows that weight below

that which is excessive may be a factor in the determination of the angle of gait, though it cannot be said to be the only important factor. There is a steady tendency for the women from 120–170 pounds to show a greater angle than those under 130 pounds. However, there also is a steady decline in the angle of gait from 90–120 pounds. Since only a few individuals are found in each of the outlying groups they should be ignored but even when this is done the above statement still holds, although the numbers in the remaining groups which range in weight from 100 to 140 pounds, are respectively only, 25, 41, 37, and 24 persons, (see Table 9).

TABLE 7.

RELATION OF WEIGHT OF INDIVIDUAL TO THE ANGLE OF GAIT

Weight in pounds	Number of individuals	Average angle of gait	Weight in pounds	Number of individuals	Average angle of gait
90–100	3	9.5	130–140	26	7.1
100–110	24	7.3	140–150	8	9.6
110–120	42	6.4	150–160	4	9.2
120–130	39	5.5	160–170	2	9.8

The larger angle of gait of the two individuals weighing under 100 pounds can probably be accounted for by the fact that they were shorter than the average individuals measured. The height of the individual giving an angle of 11.2° was 57.7 inches, the shortest of the group of 150 women. An angle of 11.0° was found in an individual 60.5 inches in height. On the other hand, of the two individuals weighing between 160–170 pounds the one with an average angle of gait of 2.7° was exceptionally tall, 67.4 inches, while the one with an average angle of gait of 16.8° was much shorter than the average. Omitting these extremes, we then find that those weighing between 100 and 130 pounds showed an average angle of gait of 6.4°, while those weighing between 130 and 160 pounds showed an average angle of gait of 8.4°.

Dougan stated that the average angle of gait increased slightly in students from freshmen in the high school to graduates in the university,

TABLE 8.

RELATION OF AGE TO ANGLE OF GAIT

Age of individual	Number of cases	Average angle of gait Right	Average angle of gait Left	Average of right and left angle of gait
16	2	5.8	5.9	5.8
17	20	6.4	6.4	6.4
18	54	5.5	7.8	6.6
19	36	7.3	6.7	6.9
20	22	7.4	7.8	7.6
21	8	7.5	8.7	8.1
22	2	3.5	0.3	1.8
23	1	15.6	2.58	9.1
24				
25	1	15.4	9.2	7.3
26	2	12.2	13.8	12.9
27	1	11.5	14.4	12.9

but advanced no reasons for this fact. I also found that the age of the individual even in so limited a range as from 16 to 27 years, is a factor in the determination of the angle of gait. The increase in the angle of gait in women within these years may possibly be due to the growth of the pelvis, which according to Litzmann increases in width until the 25th year. As the pelvis widens the femur takes on a more oblique position. This may cause the extremities to come nearer together. A wider base of support for the body would then be necessary to maintain its former equilibrium and this could be obtained by a large positive angle of gait.

TABLE 9.
RELATION OF WEIGHT TO DEFORMATION

Weight in pounds	Number of cases	Average total deformation in centimeters for both feet
90–100	3	1.79
100–110	25	2.17
110–120	41	2.29
120–130	39	2.29
130–140	24	2.11
140–150	9	2.34
150–160	4	2.47
160–170	3	1.23
	148	

Table 9 shows that the total deformation of the foot under body weight may be considered as a means of determining the strength of the foot. It however is not influenced to any great degree by body weight. The total deformation was considered to be the increase in length and width plus the depression of the arch, under body weight. There was no relation between total deformation and weight-bearing in these women, when the weight in question was that of their own bodies borne on one foot.

TABLE 10.
RELATION OF AVERAGE ANGLE OF GAIT TO TOTAL DEFORMATION IN CENTIMETERS

Average angle of gait in degrees	Number of cases	Total deformation	Average angle of gait in degrees	Number of cases	Total deformation
—4 to —2	1	2.8	6 to 8	35	1.9
—2 " 0	2	1.9	8 " 10	25	2.4
0 " 2	12	2.6	10 " 12	17	2.5
2 " 4	16	2.4	12 " 14	7	2.0
4 " 6	28	2.3	14 " 16	4	2.3

Table 10 shows that the total deformation is least when the average angle of gait lies between 6° and 8°. This angle would then seem to go with a strong foot. Since the average angle of gait for this group of women is 6.8°, and the greatest number of individuals have an average gait of from 6°–8°, might it not be logical to conclude that an angle of gait between 6° and 8° is the usual angle of gait for this group of women. However, we must bear in mind that angles not lying within this range

TABLE 11.
TABLE OF MEASUREMENTS

Number of cases	Age	Weight	Height	Height of arch in centimeters Seated Right	Seated Left	Standing Right	Standing Left	Length of foot in centimeters Seated Right	Seated Left	Standing Right	Standing Left	Width of foot in centimeters Seated Right	Seated Left	Standing Right	Standing Left	Average angle of gait Right	Left	Av.
1	22	122	66.4	7.4	6.85	6.7	6.6	24.2	24.3	24.8	24.8	9.4	9.4	9.9	9.6	2.8	0.14	1.47
2	19	131.5	63.7	7.25	7.41	6.4	6.84	24.9	24.48	25.92	24.8	9.4	8.9	9.7	9.0	9.02	11.75	10.36
3	21	127.5	65.9	6.95	7.3	6.2	5.81	25.75	25.49	25.62	25.62	9.7	10.5	9.8	11.0	7.0	5.05	6.02
4	18	130	65.1	7.32	7.7	7.41	7.21	23.5	23.16	24.6	23.99	10.1	10.0	10.2	10.2	7.7	7.98	7.84
5	21	111	63	6.90	6.85	6.35	6.22	24.2	24.4	24.89	24.8	9.0	9.2	9.4	9.75	3.43	4.36	3.89
6	19	139.5	70.2	7.65	7.9	6.8	7.21	25.22	25.89	26.6	26.5	9.7	9.4	10.0	9.65	3.8	4.86	4.33
7	19½	116	62.9	7.5	7.12	6.68	6.62	23.65	24.0	23.8	24.26	9.7	9.96	10.0	10.0	10.7	13.8	12.25
8	17	117	63.5	7.93	7.71	7.5	6.88	23.12	23.68	23.39	23.89	9.35	9.35	9.7	9.9	7.0	11.46	9.23
9	18	104.5	62.8	6.8	7.68	6.2	6.18	21.89	22.24	22.4	22.6	9.0	8.8	9.2	9.1	3.8	13.16	8.48
10	18	118	62.65	7.43	7.5	6.9	6.75	23.75	23.6	24.5	24.8	8.7	9.0	8.9	9.7	5.46	2.66	4.06
11	20	100	58.1	6.94	7.5	6.3	6.0	21.2	20.8	21.4	21.29	8.8	8.4	8.9	8.7	9.78	12.88	11.29
12	19	106.5	60.6	7.71	7.1	7.12	6.79	21.71	22.2	21.92	22.49	8.55	8.45	8.9	8.9	11.5	3.82	7.66
13	20	107	62	6.35	6.52	5.81	5.8	23.5	22.78	23.79	23.15	8.9	8.9	9.0	9.4	5.86	11.06	8.46
14	26	142	61.1	6.4	6.71	6.2	6.2	24.2	24.05	24.35	24.38	10.0	10.0	10.21	10.1	6.38	12.18	9.28
15	16½	95	60.5	6.9	6.75	6.5	6.2	22.9	22.87	23.1	22.92	8.0	8.0	8.15	8.2	11.46	10.62	11.04
16	17½	100	63.1	6.6	6.53	6.32	6.05	22.9	23.1	23.18	23.36	9.5	9.45	9.7	9.7	7.48	7.94	7.71
17	17	108	65.5	6.9	6.78	6.8	6.52	22.6	23.2	22.8	23.65	9.15	9.3	9.4	9.5	10.46	7.66	9.06
18	19	126.5	68.1	6.99	7.4	6.5	6.87	24.02	24.2	24.75	24.75	8.0	8.2	8.5	8.5	13.87	12.24	13.05
19	20	116	67.2	7.6	7.4	7.2	6.65	23.85	23.85	24.32	24.35	8.3	8.3	8.7	8.9	6.36	5.32	5.84
20	18	129	64.2	7.4	7.2	7.13	6.7	25.15	25.01	25.2	25.3	8.6	8.4	8.5	8.9	–.10	7.14	3.52
21	19	100.5	63.0	6.52	6.51	6.2	5.92	21.9	21.9	22.15	22.28	8.16	8.5	8.27	8.4	4.82	9.9	7.36
22	19	130	67.8	7.03	6.8	6.75	6.27	25.16	25.01	25.36	25.25	8.8	8.9	9.0	9.0	–5.07	2.32	–1.37
23	18	130	63.5	7.0	6.86	6.8	6.46	23.76	23.85	23.88	23.92	8.45	8.6	8.5	8.35	5.72	3.1	4.41
24	18	94.5	61.0	6.58	7.19	6.45	6.82	22.41	22.35	22.55	22.6	7.6	8.0	8.0	8.0	4.56	7.76	6.16
25	18	148	65.2	6.2	6.35	5.75	5.75	23.7	23.6	24.18	24.18	8.16	8.3	8.4	8.7	9.3	13.74	11.52
26	19	102	63.2	6.76	6.81	6.62	6.37	23.45	23.2	23.68	23.7	8.05	7.9	8.5	8.1	10.37	13.64	12.0
27	18	134.5	66.7	7.3	7.08	6.92	6.52	23.72	23.52	23.8	23.9	8.7	8.9	9.2	9.5	5.84	7.24	6.54
28	18	114.5	64.1	7.21	7.5	6.52	6.6	24.92	24.55	25.09	24.98	8.1	8.05	8.4	8.5	8.4	8.22	8.31
29	19	117	62.5	7.05	7.2	6.43	6.5	22.81	22.87	23.2	23.25	8.5	8.3	8.9	8.75	8.5	8.98	8.74
30	20	112	61.8	6.99	6.95	6.85	6.22	22.85	22.16	23.1	23.35	7.75	8.8	8.2	8.9	5.02	4.5	4.70
31	18	111	65.3	7.2	7.2	6.72	6.68	24.3	23.92	24.5	24.4	7.7	7.55	7.9	7.8	5.5	5.48	5.49
32	19	132.5	67.1	6.83	7.02	6.58	6.4	24.95	24.7	25.12	24.83	8.5	8.7	8.7	8.9	6.13	6.78	6.45
33	19	131.5	66.3	7.55	7.55	7.35	6.95	25.3	25.38	25.5	25.61	8.8	8.7	9.2	9.1	7.0	3.4	5.2
34	18	118	67.2	6.37	6.52	5.98	6.0	24.2	24.4	24.87	25.0	8.2	7.9	8.4	8.2	10.18	8.0	9.09
35	18	104	61.3	6.21	6.25	5.9	5.76	22.25	22.25	22.4	22.21	8.1	8.0	8.1	8.4	1.94	1.61	1.77
36	18	129	66.2	6.77	6.12	6.3	6.15	24.4	24.4	24.7	24.8	8.1	8.1	8.5	8.4	5.18	7.12	6.15

37	17	120	64.4	7.08	7.18	6.8	6.65	23.19	22.7	23.5	23.45	8.5	8.5	8.6	8.7	1.69	5.1	3.39
38	18	131	66.3	6.68	6.62	6.32	6.0	24.25	24.0	24.5	24.12	7.9	7.8	8.2	8.0	8.0	6.58	7.29
39	18	112	66.0	6.55	6.4	6.1	5.85	24.2	24.32	24.45	24.5	7.9	8.15	8.1	8.3	–3.5	1.52	0.99
40	18	125	67.1	7.2	7.1	6.82	6.4	24.0	24.45	24.4	25.15	8.1	8.1	8.7	8.5	1.96	6.38	4.17
41	18	130.5	67.3	7.0	7.5	6.85	7.01	23.5	23.38	23.6	23.38	8.0	7.89	7.9	8.2	3.08	10.87	6.97
42	17	135.0	66.5	7.1	6.7	6.48	6.45	26.25	26.0	26.5	26.2	8.4	8.5	8.75	8.7	10.36	9.02	9.69
43	18	136.5	67.9	6.82	7.1	6.37	6.6	25.0	25.0	25.35	25.35	8.2	8.2	8.5	8.3	–2.04	0.46	–.79
44	17	119.5	64.7	6.25	6.5	5.9	5.85	24.4	24.2	24.5	24.55	8.9	8.45	9.2	8.6	4.26	0.94	2.59
45	18	141.5	62.5	6.8	7.1	6.3	6.88	23.6	23.35	24.0	23.6	7.8	7.54	8.25	7.8	10.26	13.0	11.63
46	19	111.5	63.0	5.92	6.25	5.7	5.8	21.65	21.65	21.85	21.95	7.8	7.7	8.0	7.7	6.68	5.0	5.84
47	18	127.5	64.6	6.37	6.25	6.2	5.8	22.65	22.98	22.9	23.3	7.8	7.75	8.2	7.9	5.64	11.48	8.56
48	19	105.5	61.6	6.15	6.16	5.8	5.75	21.1	21.34	21.4	21.7	7.75	7.7	7.83	7.8	10.88	10.12	10.5
49	21	106	61.0	6.28	6.55	6.3	6.22	22.25	22.48	22.81	22.97	7.7	7.9	7.9	8.0	6.96	6.34	6.65
50	19	119.5	63.1	6.52	6.5	5.93	6.05	21.9	21.75	22.25	22.28	8.2	8.3	8.5	8.4	7.8	9.1	8.4
51	19	108.0	63.3	5.96	6.68	5.8	6.15	23.25	23.1	23.5	23.65	8.45	8.1	8.5	8.1	8.87	–4.78	2.04
52	17	114.5	62.4	6.4	6.6	6.2	6.0	23.3	23.2	23.5	23.55	7.9	7.6	8.1	8.2	1.22	4.4	2.81
53	19	158.5	64.1	6.85	6.7	6.5	6.25	22.4	22.6	22.6	22.75	8.5	8.4	8.7	8.4	16.8	11.05	13.92
54	19	121	65.7	6.2	5.9	5.95	5.5	23.1	23.25	23.35	23.5	8.1	8.15	8.2	8.7	0.55	2.52	1.53
55	19	119.5	63.7	6.9	6.85	6.5	6.35	23.95	23.85	24.1	24.1	8.3	8.1	8.8	8.1	8.06	5.0	6.53
56	18	115.5	67.9	6.56	6.7	6.45	5.95	23.0	23.0	23.1	23.4	7.8	8.1	8.0	8.2	7.78	6.14	6.96
57	17	109.5	63.6	5.85	6.1	5.7	5.75	23.3	23.6	23.8	24.05	7.6	7.75	7.9	7.9	9.96	2.93	6.45
58	19	122.25	66.4	6.95	6.72	6.55	6.25	23.56	24.2	23.9	24.4	7.75	7.85	8.15	8.1	7.56	4.25	5.9
59	17	108	63.8	6.5	6.6	6.0	6.0	23.2	23.2	23.5	23.5	8.5	8.35	8.75	8.35	11.44	10.5	10.92
60	20	135	64.4	5.9	6.4	5.7	5.75	23.15	22.5	23.4	22.95	7.65	7.6	7.95	7.75	13.22	11.46	12.34
61	20	104	64.3	6.0	6.55	5.75	5.8	24.2	23.9	24.5	24.6	7.6	7.5	8.0	8.0	5.3	3.82	4.56
62	18	124	65.3	6.85	7.1	6.55	6.45	25.28	25.4	25.3	25.6	8.3	8.1	8.75	8.2	7.12	5.76	6.44
63	17	125.5	62.5	6.3	7.0	6.1	6.22	23.1	23.0	23.3	23.2	8.3	7.82	8.6	8.5	1.98	3.31	2.64
64	20	115	62.2	6.25	6.55	5.9	6.1	22.85	22.9	23.05	23.2	8.2	8.15	8.55	8.35	11.06	8.66	9.86
65	20	133	65.8	6.4	6.55	5.9	6.0	23.65	23.45	23.9	23.9	8.4	7.7	8.4	7.75	3.67	6.08	4.87
66	18	131	66.1	6.19	6.5	6.1	5.8	24.0	23.9	24.0	24.3	8.1	8.0	8.25	8.45	9.65	11.45	10.55
67	20	120.5	68.3	5.89	6.2	5.9	5.75	24.8	24.75	24.85	25.0	7.6	7.8	7.8	8.1	4.34	10.15	7.24
68	20	126	64.7	6.1	6.45	5.8	5.75	23.8	23.5	24.1	23.85	8.9	8.4	9.0	8.8	4.1	6.7	5.4
69	19	145	68.4	7.1	6.95	7.0	6.57	24.4	25.15	24.7	25.3	8.6	8.5	8.7	8.8	10.95	2.52	6.73
70	17	109.5	64.0	5.95	6.1	5.5	5.4	23.6	23.5	23.8	23.85	7.5	7.35	7.9	7.85	11.28	7.12	9.2
71	19	144	63.5	6.4	6.3	5.8	5.7	23.1	23.25	23.5	23.6	8.35	8.35	8.7	8.95	9.58	8.38	8.95
72	19	119	61.6	5.85	6.05	5.3	5.4	22.75	22.2	23.0	22.5	7.35	7.45	7.9	7.9	8.32	10.74	9.53
73	18	124.9	65.4	6.4	6.5	6.2	5.95	24.25	23.9	24.5	24.3	7.75	7.8	8.0	8.25	6.74	3.5	5.12
74	21	116.5	62.2	6.23	6.4	5.85	5.75	23.65	23.4	23.95	23.7	7.8	7.95	8.4	8.35	10.78	17.7	14.24
75	18	119.5	65.8	6.6	6.5	6.38	6.05	22.85	23.5	23.35	24.2	7.6	7.7	8.05	8.0	10.58	6.53	8.55

TABLE 11.—*Continued.*

Number of cases	Age	Weight	Height	Height of arch in centimeters				Length of foot in centimeters				Width of foot in centimeters				Average angle of gait		
				Seated		Standing		Seated		Standing		Seated		Standing				
				Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Av.
76	18	111	64.8	6.1	6.15	6.0	5.75	22.3	22.4	22.4	22.0	7.4	7.5	7.5	7.7	6.7	6.0	6.35
77	18	115.5	63.9	5.95	5.9	5.7	5.62	24.2	24.2	24.5	24.7	7.65	7.8	8.38	8.5	5.16	5.8	5.48
78	19	132	64.8	6.1	6.25	5.75	5.7	25.2	25.48	25.5	25.7	8.65	8.55	8.75	9.1	5.3	8.86	7.08
79	21	126.5	64.5	6.2	6.1	5.9	5.62	23.4	23.75	23.85	24.1	8.0	8.2	8.5	8.6	6.06	8.43	7.24
80	18	115	65.2	6.15	6.1	5.95	5.6	24.3	24.25	24.35	24.5	7.7	7.65	8.05	8.2	4.6	8.18	6.39
81	19	144	63.5	5.95	5.95	5.7	5.2	22.5	22.4	22.8	23.0	8.0	7.65	8.2	8.35	6.94	5.9	6.42
82	18	165.5	67.4	6.5	6.95	6.5	6.4	26.25	26.45	26.25	26.6	8.5	8.4	8.75	8.95	2.2	3.15	2.67
83	20	115.5	62.5	6.36	6.3	6.05	5.55	23.1	23.3	23.45	23.55	7.9	7.9	8.1	8.25	6.98	5.58	6.28
84	18	158.5	70.3	6.3	6.65	6.2	5.75	25.05	25.1	25.65	25.7	8.7	8.7	8.8	8.6	4.21	6.32	5.26
85	19	154.0	66.7	6.4	6.45	5.7	5.85	25.35	25.45	25.7	25.9	8.6	8.45	9.2	8.5	13.32	14.88	13.9
86	18	120	64.6	5.9	6.35	5.95	5.9	25.2	25.15	25.3	25.35	8.6	8.35	8.6	8.65	3.3	3.92	3.61
87	20	120.5	68.3	6.4	6.7	6.0	6.05	25.6	25.3	25.88	25.7	8.5	8.05	8.6	8.7	5.28	5.48	5.38
88	17	112.5	64.4	5.9	6.1	6.3	6.6	23.3	23.1	23.1	22.8	8.3	8.25	8.0	7.8	1.56	-.72	0.42
89	19	108.5	63.5	5.9	6.4	5.4	5.3	24.5	24.4	24.9	25.1	7.6	7.25	8.1	7.85	0.92	0.31	0.66
90	18	135.5	63.6	6.7	6.4	6.05	5.4	23.55	23.5	23.85	24.1	8.2	8.1	8.5	8.8	-2.68	3.08	0.2
91	20	126.5	65.0	6.1	6.0	5.8	5.4	22.7	22.7	23.0	22.95	7.5	7.25	7.8	7.75	10.15	7.23	8.69
92	20	——	——	6.2	6.2	5.7	5.6	20.0	19.9	20.2	20.3	7.4	7.75	7.5	8.05	13.78	11.02	12.40
93	22	122.5	68.	7.2	7.2	6.7	6.45	24.5	24.3	24.9	24.75	8.15	8.3	8.9	8.9	4.14	0.55	2.34
94	18	126.0	67.2	6.65	6.9	6.3	6.3	25.4	25.2	25.6	25.6	8.85	8.4	9.1	9.0	11.74	16.76	14.25
95	18	104.5	64.5	6.3	6.6	6.15	6.05	23.3	23.4	23.65	23.7	8.1	8.15	8.5	8.7	2.56	4.66	3.61
96	20	127.5	64.4	5.6	5.6	5.0	4.85	24.1	24.4	24.65	24.7	8.0	8.2	8.4	8.5	8.37	12.34	10.35
97	21	127.5	67.3	6.3	6.35	5.9	5.75	22.3	22.35	22.6	22.9	7.6	7.55	8.0	8.1	10.46	8.16	9.31
98	18	123	66.2	6.15	6.35	5.8	5.95	24.3	24.3	24.6	24.7	8.5	8.35	8.5	8.75	14.4	6.74	10.07
99	17	121.5	64.1	5.85	5.9	4.75	4.85	22.65	23.15	23.05	23.65	7.6	7.7	8.15	8.25	2.7	2.15	2.42
100	19			5.5	6.25	5.3	5.65	25.0	24.9	25.3	25.2	8.1	7.8	8.55	8.3	5.45	4.58	5.01
101	16	124.5	61.8	6.45	6.6	5.9	5.75	24.4	24.3	24.75	24.7	8.3	8.2	8.55	8.5	-.06	1.16	0.5
102	23	106	61.6	5.8	6.2	5.6	5.7	23.0	23.0	23.1	23.4	7.8	7.5	7.95	8.0	1.56	2.58	1.57
103	20	109	63.0	6.1	6.0	5.9	5.6	22.4	22.25	22.65	22.4	7.4	7.6	7.5	7.6	8.76	4.7	6.73
104	21	103.5	62.0	5.8	5.95	5.4	5.55	22.8	22.6	23.3	23.2	7.8	7.8	8.3	8.5	11.18	11.25	11.21
105	20	122	60.6	5.75	5.4	5.5	5.0	22.1	22.4	22.3	22.85	8.0	8.2	8.0	8.75	3.08	5.08	4.08
106	18	119	63.0	5.9	6.0	5.55	5.5	22.6	22.5	23.05	23.1	7.8	7.8	8.2	8.25	-8.3	0.36	-3.97
107	18	117.5	62.4	6.5	5.65	6.4	5.05	23.1	23.5	23.1	23.7	7.5	8.0	7.8	8.4	5.3	8.64	6.97
108	19	133.5	65.5	5.8	5.75	5.65	5.25	26.0	25.8	26.15	26.25	8.15	8.2	8.35	8.9	8.62	3.42	6.02
109	18	122	62.7	6.4	6.5	5.85	5.8	23.05	23.1	23.4	23.6	7.4	7.55	7.7	7.75	4.88	10.88	7.38
110	18	150	64.8	6.9	6.9	6.0	5.65	23.8	23.6	24.2	24.3	8.4	8.15	8.9	8.9	2.31	4.78	3.54

111	20	134.5	66.4	6.7	6.85	6.35	6.25	24.35	24.3	24.5	24.5	8.5	8.2	9.0	9.0	6.93	8.84	7.88
112	18	108.5	60.2	5.7	5.7	5.3	5.3	22.35	22.55	22.65	22.9	7.65	7.5	7.8	7.9	5.6	10.06	7.83
113	18	125.7	62.7	6.05	6.04	5.9	5.6	22.8	22.8	22.95	23.35	8.0	8.25	8.1	8.65	6.3	1.98	4.14
114	18	121	66.8	7.0	6.9	6.55	6.1	24.2	24.35	24.6	24.8	8.05	8.1	8.6	8.65	–3.8	4.9	0.55
115	18	111.5	62.0	5.4	5.35	5.4	5.0	23.2	22.95	23.3	23.45	8.5	8.1	8.7	8.5	14.48	14.43	14.45
116	18	110	60.6	6.45	5.6	5.75	5.1	24.35	22.3	24.65	24.4	8.5	8.75	8.8	9.0	5.56	10.98	8.27
117	18	139	65.1	6.0	6.4	6.0	5.95	24.9	24.6	25.1	25.0	8.0	8.3	8.2	8.5	4.5	6.48	5.49
118	18	162.5	61.9	5.6	5.9	5.45	5.3	23.6	23.05	23.8	23.4	9.0	8.6	9.15	9.1	6.5	10.76	8.63
119	19	110	64.3	6.45	6.25	6.05	5.6	23.5	23.4	23.7	24.0	8.05	8.2	8.6	8.8	7.3	5.86	6.58
120	19	116.5	65.4	6.4	6.65	6.15	6.1	23.5	23.5	23.7	23.9	8.3	8.15	8.5	8.6	5.0	4.68	4.84
121	19	129	66.9	6.55	6.4	6.1	6.05	24.2	24.3	24.5	24.5	8.4	8.1	8.5	8.4	3.56	9.2	6.38
122	17	169	69.1	6.35	6.85	5.9	6.2	26.1	26.0	26.4	26.45	9.1	8.6	9.3	9.1	11.3	10.32	10.81
123	18	124.5	67.3	6.15	6.0	6.1	5.85	24.8	24.6	24.8	24.8	8.6	8.6	8.7	8.9	0.88	0.32	0.60
124	19	104	62.9	6.3	5.9	6.1	5.4	22.9	22.7	23.05	23.1	7.35	7.2	7.6	7.6	9.12	6.64	8.88
125	19	120	63.2	5.95	5.7	5.6	5.25	23.35	23.6	23.7	24.1	7.6	7.2	7.9	7.9	2.06	5.94	4.00
126	17	112.5	65.4	6.5	6.4	6.1	5.75	24.1	24.4	24.5	25.0	7.6	7.6	8.25	8.0	12.32	5.52	8.92
127	17	124	63.0	6.15	6.4	5.85	5.8	22.3	22.1	22.9	22.75	7.4	7.7	7.9	8.0	2.98	10.16	6.52
128	19	111.5	62.7	5.35	5.9	5.2	5.2	23.2	23.0	23.52	23.3	8.25	8.0	8.4	8.4	5.71	0.84	3.27
129	17	129.5	66.8	6.23	6.15	6.15	5.7	24.6	24.65	24.6	25.0	8.3	8.1	8.5	8.7	2.9	6.86	3.88
130	17	133	63.9	6.55	6.5	5.95	5.8	22.85	22.92	23.4	23.48	7.8	7.75	8.8	8.4	4.86	7.22	6.04
131	18	133.5	64.3	5.85	5.8	5.75	5.35	23.9	23.65	24.5	24.1	7.9	7.85	8.3	8.25	14.24	6.26	10.25
132	20	119	67.4	6.15	6.5	5.8	5.92	25.15	24.85	25.35	25.25	7.8	7.95	8.25	8.4	11.22	9.22	10.57
133	18	114	63.0	6.2	6.38	5.8	5.85	23.6	23.58	23.9	23.9	7.8	7.85	8.2	8.2	4.97	0.76	2.86
134	20	121	66.2	5.75	6.05	6.0	5.65	25.75	25.4	25.85	25.75	8.25	8.3	8.6	8.75	4.02	7.87	5.94
135	19	134.5	63.2	6.15	6.25	5.83	5.5	23.75	23.5	24.0	24.0	8.2	7.8	8.25	8.4	5.62	4.02	4.82
136	19	112.5	63.5	5.8	6.5	5.65	6.0	23.7	23.9	23.9	24.5	8.35	8.2	8.3	8.7	5.52	9.67	7.59
137	21	118	61.3	6.25	6.45	5.95	5.85	23.3	23.4	23.6	23.85	8.3	7.9	8.5	8.5	3.62	5.55	4.58
138	18	120	66.3	6.4	6.55	6.0	5.95	22.75	22.75	23.25	23.25	7.5	7.45	7.85	8.0	9.64	6.16	7.9
139	18	130.5	63.5	5.75	5.7	5.4	5.2	22.85	22.5	23.3	23.35	8.25	7.9	8.3	8.35	15.66	15.72	15.69
140	17	115	63.9	5.35	5.53	5.0	5.0	23.7	23.4	24.0	23.85	8.0	7.85	8.1	8.1	2.88	2.22	2.55
141	18	125	65.35	5.45	5.5	5.0	4.9	24.1	24.2	24.48	24.5	8.1	8.1	8.48	8.6	6.55	8.14	7.34
142	17	102	64.9	6.3	6.5	5.8	5.5	23.3	23.0	23.8	23.7	7.7	7.7	8.3	8.6	9.42	13.58	11.50
143	18	125	63.35	6.15	5.52	5.8	5.3	24.3	24.0	24.6	24.4	7.3	7.25	7.7	7.6	8.82	8.34	8.58
144	26	112	61.5	5.5	5.9	5.45	5.2	22.6	22.9	22.8	23.3	7.7	7.4	7.8	7.75	17.98	15.4	16.69
145	21	114	67	6.0	6.5	5.7	5.8	23.7	23.65	24.2	23.65	7.5	7.0	7.6	7.9	0.66	5.76	3.21
146	25	130	62.5	5.75	5.55	5.6	5.1	22.75	22.45	22.7	22.65	8.1	8.0	8.45	8.1	15.4	9.2	13.3
147	27	131	63.5	5.45	5.55	5.2	4.95	23.89	24.0	24.2	24.3	7.9	8.0	8.3	8.0	11.47	14.38	12.92
148	18	115	60.7	6.2	6.3	5.95	5.6	22.2	22.4	22.3	22.7	7.6	7.3	7.6	7.7	5.4	2.26	3.83
149	20	96	57.7	5.6	5.85	5.4	5.35	22.8	22.25	23.1	22.9	7.2	7.1	7.5	7.5	9.71	12.7	11.20
150	19	147.5	66.3	5.8	5.85	5.7	5.3	25.15	25.3	25.6	25.8	8.55	8.2	8.9	9.0	6.54	4.3	5.42

are not necessarily abnormal for the angle probably is influenced by various factors such as heredity, age, and, to some extent also by weight and height. Length of foot, width of pelvis, torsion, the collo-diaphysial angle, and previous habits of life and activity may also influence it. The angle of gait which is the smallest is not necessarily the normal angle, nor does it imply the possession of the strongest foot. This being true, an unnecessary concern is awakened in an individual, and an unnecessary burden put upon him when he is told that his arch is too low and advised to walk parallel in order to increase the height of the arch. It is not necessarily easier or more natural to toe straight.

I regret that my determinations rest on so small a number of cases, but as Dougan's on men, they not only represent a beginning but are the only definite determinations ever made. I am indebted to Miss Bunting, her assistants and to students in the Stanford University gymnasium for their kind and generous cooperation, and thank Dr. Meyer for suggesting the theme and the method, and for the privilege of working under his guidance.

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COMPOSITE STUDY OF WEIGHT OF VITAL ORGANS IN MAN

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INTRODUCTION

This paper deals with investigations into the weight of the human heart, liver, spleen, and kidneys, in relation to age, sex, race, type, stature, nourishment, and acute and chronic diseases.

Many efforts have been made to determine the weight of the normal organs, but we seem to be about as far as ever from arriving at an average weight. From the time of Boyd and Bischoff to the work of Greenwood and Brown investigations have not been lacking. Recently Donaldson and others at the Wistar Institute, Jackson, Scammon, Bardeen, Baker and Bean have added to these investigations. Vierordt has tried by massing data to give an approximate normal average weight. When these investigations are compared with text books of anatomy and treatises on medicine and surgery one realizes that many averages have been found. Weights collected from insane asylums and hospitals unless a critical selection is made are manifestly abnormal. Accident cases may be abnormal if diseased, and would show the results of shock if death were instantaneous, and the result of infection if death comes later. Even in cases of instantaneous death the chemical and vasomotor reactions may be different in different individuals or in the various organs of the same individual. Colloidal conditions influence weight and they may vary from time to time in the same person or in different organs.

Death is abnormal in relation to the living, and the organs after death are not the same as the organs during life. Methods may be devised for estimating the weight of the organs in the living, but such methods are liable to so many and such gross errors that they have not been perfected and utilized. Bardeen has developed a method of approximating the weight of the heart in the living but it has not come into general use.

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Those who die of acute conditions such as pneumonia and typhoid fever should be considered as abnormal as those who die of chronic conditions such as tuberculosis and pellagra, because the two pairs of diseases may attack those who are of different types, and one type may be quite as near the normal as the other.

There is need for more complete records of family and personal characters, of heredity and environment, as well as some anthropometry, such as measurements of stature, vertex to ischium, shoulder and hip breadth, and hand and foot length and breadth. A few such measurements would be of value in demonstrating human types. Certain observations which would show the physiological types as used in European clinics might be of service. The physiological condition at death in relation to the vasomotor and other systems should be ascertained if possible, and the colloidal condition of each organ. The relative size of the cells and the amount of fat and connective tissue in each organ would be of value. When the pathological records have been perfected the study of organ weight will be more fruitful.

It is thought advisable in the present work to attempt to show the relation of certain factors that have a bearing on the variability of organ weight, and thus more nearly approximate the normal. The purpose of this investigation therefore is to find the weight of an organ in a given sex, race or type, at a certain age and stature, with the condition of nourishment, and with either acute or chronic disease as the cause of death.

MATERIALS

Records of 4,871 persons were available for organ weights in the present study, from the first 5,000 necropsies at the Johns Hopkins Hospital, the first 6,000 at the Charity Hospital, New Orleans, the first 2,000 at the Touro Infirmary, New Orleans, and the first 1,000 at the University of Virginia Hospital. I wish to thank Drs. MacCallum, Duval, Couret and Marshall for the use of these records. Of the total number 3,508 were male and 1,363 female, distributed as follows:

TABLE 1.

Number of Records Used

	W. M.	C. M.	W. F.	C. F.	Male	Female
J. H. H.......	986	648	383	369	1634	752
C. H. & T. I...	492	843	107	263	1335	370
U. Va. H......	34	35	19	23	69	42
No race given..					470	199
Total.........	1512	1526	509	655	3508	1363

The records from the Johns Hopkins Hospital and the Touro Infirmary represent a better class than those from the other Hospitals,

those from the University of Virginia represent a rural population, whereas those from the Charity Hospital represent the submerged tenth, the derelicts from New Orleans and the Gulf States. The weight of the organs from the Charity is slightly less than that from the others. The total lot of organs would be about as representative as could be found for the total population. The population of the United States in general would be of a better class, and would certainly not have so many of the submerged tenth as found in the records for the present study. The racial aspect of New Orleans is somewhat South European from the French and Spanish, or Creole population, as it is called, and the racial population of Baltimore is more North European because of the large German element there and the large North European element in the population of the states adjoining Maryland from which a considerable part of the Johns Hopkins Hospital population is drawn.

METHODS

Previous publications by Bean and Baker included the use of organs that showed no gross pathologic lesion that seemed materially to alter the weight. This method involved the study of each organ in many ways. Each organ was discussed in relation to many factors that might influence its weight. A large part of three years was spent in the study that resulted in the subsequent publications in the AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY. The records published then may represent a fairer weight for normal organs than any other, but the method was time consuming and involved the personal equation to so large an extent that a revision was decided upon when more records became available. The revision consists in eliminating all organs which showed any gross pathological lesion whether the lesion seemed to alter the weight or not. This eliminates a greater number of organs and slightly reduces the average weight. Rather than retain any abnormal organs some normal organs may have been discarded. All spleens in typhoid fever were discarded even though no note was found of any pathologic lesion in the spleen. Likewise all livers in chronic passive congestion were discarded.

The work involves a study of each pathologic record to find the organ weight when present, and to tabulate the weight when found. Then the record of each organ was studied to determine the presence or absence of any pathologic lesion, and if present its extent. Afterwards the organs were divided into three groups:

1. Those in which the lesion was so great that it materially altered the weight of the organ.

2. Those in which the lesion did not seem materially to alter the weight of the organ.

3. Those in which there was no gross pathologic lesion.

The present study involves chiefly the third group.

The pathologic record was further studied as to race, sex, type, age, stature, nourishment, and disease of the person.

Race. Only white and colored people are concerned. The white people are almost entirely American and so are the colored. The latter represent the American Negro with some admixture of American White and a little of the American Indian. The relative proportion of each cannot even be approximated, although a considerable proportion have white blood.

Type. The type is considered in only a few hundred persons. This is determined by a study of the ears, nose, face, cranium and other body parts.

Sex. This is obvious.

Age. The age is divided into groups of five years between 20 and 30, and into groups of ten years after 30. This gives a series of 9 groups which is a sufficient number with which to differentiate but not so many as to confuse.

Stature. The stature is divided into 5 centimeter groups which also gives a series of 9 groups.

Nourishment. Some difficulty was experienced in grouping the conditions of nourishment because of the lack of uniformity in the terminology, but after studying the methods of the pathologists at the different hospitals a fairly uniform grouping resulted.

Four groups were selected, (a) Fat, (b) Well nourished, (c) Thin, and (d) Emaciated. Fat and obese were put together, very well nourished was put under well nourished, as well as such terms as nourishment good, fair or normal. Poorly nourished, under nourished, very thin, and like terms were put under thin. Extremely emaciated, very much emaciated, extremely thin and like terms were included under emaciated.

When considering acute and chronic diseases, acute include chiefly lobar pneumonia, typhoid fever, and acute infections; and chronic diseases include chiefly tuberculosis, carcinoma and chronic infections. Sudden deaths were not included, neither was syphilis because the organs were invariably large; and heart and kidney diseases were not included because there are both acute and chronic conditions, and the weights of the organs are variable in each condition.

The average weight as well as all other calculations were done by one person and verified by two others. The author is alone responsible for the accuracy of the computations, although in this he was assisted by his wife and eldest son and daughter.

THE INDEX OF VITALITY

The index of vitality is the percentage of normal to abnormal organs in the group. If a greater number of one organ than of another is diseased it is presumed that the organ which is diseased is less resistant to disease than the one which is not diseased. The vitality of an organ is therefore in proportion to the number of normal and inverse to the number of abnormal in the group.

Heart. The index for the white male is 87.4 and for the white female it is 128.2. This means that there are 87.4 normal to 100 abnormal hearts in the male, and 128.2 normal to 100 abnormal in the female. The index for the colored male is 85.7 and for the colored female it is 117.0. The racial difference is slight but favorable to the white. The sexual difference is great and favorable to the female with the white female more favorable than the colored. What is the explanation? The answer to this would require too great an excursion into medicine and pathology. Heart disease according to Osler is the direct result of worship at the shrines of Bacchus and Vulcan, Mars and Venus. Wine and work, war and women affect men more than women. Acute infections also play a part in the etiology of heart disease, and in the records used for the present work acute infections are more common in men than in women as a cause of death. These factors if no others play a part in the greater number of diseased hearts among men than among women.

Liver. The index for the white male is 63.8, and for the white female it 57.6. The index for the colored male is 76.4 and for the colored female it is 67.1. Neither racial nor sexual difference is great. The index is much less for the heart than for the liver, especially in the female.

Spleen. The index for the white male is 54.0 and for the white female it is 61.1. The index for the colored male is 70.3 and for the colored female it is 87.1. The index is about the same as for the liver, although it is favorable to the female instead of the male. The sexual difference is greater in the colored than in the white.

Kidneys. The index for the white male is 33.5 and for the white female it is 40.2. The index is 32.9 for the colored male and 40.0 for the colored female. There is no racial difference but the sexual difference is considerable and favorable to the female. The heart and kidneys are

alike in having a highly favorable female index, although that of the heart is 300 percent greater than that of the kidneys.

The two outstanding deductions from the study of the index of vitality are that the heart has a higher index than the kidneys and the female a higher than the male. Stated in another way the kidneys have about half the chance of the heart to survive without disease until death, and a greater chance in the female than in the male. Or in still another way, the kidneys should give out before the liver and spleen and these two before the heart; women should live longer than men; and the kidneys are the first of the four organs to succumb to disease. The deductions are tentative and await further evidence for corroboration.

THE AVERAGE WEIGHT IN RELATION TO AGE, SEX, AND RACE

The average weight of the male heart, liver and kidneys between 20 and 60 years is 298.1, 1644.3 and 344.5 grams, and of the female 252.4, 1411.3 and 312.0 grams respectively. The weight of the white male spleen is 141.3, of the colored male 122.1, of the white female 115.3 and of the colored 97.2 grams.

TABLE 2.

THE WEIGHT OF THE HEART. AVERAGES.

Age	Male		Female		White				Colored			
					Male		Female		Male		Female	
	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight
20–24	203	285.4	117	236.2	53	269.3	32	221.5	133	288.1	74	240.5
25–29	157	287.1	115	243.9	58	274.6	33	226.1	88	297.2	68	252.7
30–39	352	297.6	191	249.8	147	289.1	80	263.3	178	303.7	102	240.1
40–49	325	300.3	128	264.5	159	295.2	67	256.1	140	306.3	51	275.2
50–59	251	307.2	80	264.1	140	307.9	40	262.5	88	313.8	34	266.3
60–69	155	318.6	39	281.0	94	315.1	20	284.2	46	328.0	17	291.8
70–79	68	325.2	17	289.7	43	333.1	12	308.2	20	324.2	5	245.4
80–89	17	305.2	1	290.0	6	318.3	2	255.2	11	297.9	5	304.0
20–59	1377	298.1	647	252.4								

Heart. The heart weight of the male increases from 285.4 grams at 22.5 years to 325.2 grams at 75 years, although the weight is only 305.2 grams at 85 years. The heart weight of the female increases from 236.2 grams at 22.5 years to 290.0 grams at 85 years. The heart of the colored male is about 20 grams heavier than that of the white male between 20 and 30 years, 15 grams heavier between 30 and 40 years, 10 grams heavier between 40 and 70 years, but the white male heart is 10 grams heavier than the colored male between 70 and 80 years and 20 grams heavier between 80 and 90 years. Similar differences are noted between the females of the two races although there is a slight irregularity in the differences of the latter.

The heart weight increases in size up to the time when senile changes may affect its weight therefore it is difficult to decide when the heart

weight is that of maturity. It seems to have reached a more stable weight between 20 and 30 years than before or after, therefore we may consider that it has attained its definitive adult weight at the age of 20 years. This is also true for the other organs. The body grows after the age of 20 years, but the organs mature earlier. After 60 years the adult becomes abnormal as a result of age changes in all the tissues of the body, therefore the heart weight as given from 20 to 60 years is the normal adult weight. This is in round numbers 300 grams for the male and 250 grams for the female.

Liver. The liver weight of the male decreases from 1716.9 grams at 22.5 years to 1291.4 grams at 85 years. The liver weight of the female decreases from 1463.4 grams at 22.5 years to 1107.1 grams at 85 years. The liver of the white male and female is about 50 to 100 grams heavier at all ages than that of the colored up to 80 years. After this age the liver of the colored male and female is larger than that of the white, but there are so few records at the advanced ages that this may not be significant.

TABLE 3.

THE WEIGHT OF THE LIVER. AVERAGES.

Age	Male		Female		White				Colored			
					Male		Female		Male		Female	
	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight
20–24	170	1716.9	78	1463.4	52	1748.2	22	1495.9	87	1689.9	44	1456.9
25–29	145	1729.3	63	1413.5	48	1748.7	15	1345.5	88	1705.4	42	1468.1
30–39	273	1667.1	119	1444.5	100	1699.0	48	1502.4	148	1656.2	65	1409.5
40–49	301	1643.5	102	1384.2	128	1703.2	41	1410.5	143	1602.5	49	1363.4
50–59	142	1561.0	65	1372.7	102	1608.4	31	1413.0	92	1530.0	26	1351.2
60–69	182	1482.9	46	1315.3	97	1502.8	16	1346.3	63	1454.4	26	1275.0
70–79	90	1458.3	17	1217.7	52	1541.6	10	1276.4	28	1335.9	7	1135.3
80–89	24	1291.4	7	1107.1	9	1260.0	3	1013.3	10	1302.4	3	1240.0
90–99	4	1302.8			1	1050.0	2	1400.0				
100–									1	970.0		
20–59	1186	1644.3	437	1411.3								

Kidneys. The weight given is that of the two kidneys combined or if the weight of only one kidney is given in the record this is doubled. The kidney weight of the male remains the same between 20 and 60 years, about 350 grams, but decreases thereafter until at the age of 85 years it is 282.5 grams. The kidney weight of the female also remains about the same between 20 and 60 years, a little over 300 grams, but decreases thereafter until at the age of 85 years it is about 250 grams. The weight of the kidneys is somewhat irregular from decade to decade, especially among the females, probably because of the small numbers at each age. The embryology of the kidneys would lead one to believe that they would be variable in the adult, and there is a suggestion of this in the variable number of blood vessels, and other congenital ab-

normalities. There is no significant difference between the races in the kidney weight in either sex.

TABLE 4.

THE WEIGHT OF THE KIDNEYS. AVERAGES.

Age	Male		Female		White Male		White Female		Colored Male		Colored Female	
	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight
20–24	95	348.4	59	301.6	35	343.5	17	314.4	53	349.1	39	296.2
25–29	109	343.0	55	324.8	43	325.3	16	299.6	62	354.9	35	338.1
30–39	177	344.4	102	321.0	70	328.3	44	324.1	94	355.3	54	375.7
40–49	187	355.2	69	298.5	92	360.5	37	299.5	79	356.7	29	302.2
50–59	133	336.3	40	310.3	67	339.8	18	281.4	58	337.2	20	335.3
60–69	78	328.7	12	320.0	52	328.8	7	304.3	17	340.6	5	343.0
70–79	28	327.4	12	244.2	16	339.3	7	244.3	10	313.1	5	244.0
80–89	4	282.5	2	255.0	2	247.5			2	317.5		
90–99	2	290.0			2	290.0						
100–			1	260.0								
20–59	780	344.5	331	312.0								

Spleen. The spleen weight of the male, white and colored, decreases from 138.2 grams at 22.5 years to 89.2 grams at 85 years of age. The decrease is not great up to 50 years, but the weight drops rapidly after that age. The spleen weight of the female, white and colored, decreases from 110.2 grams at 22.5 years of age to 71.4 grams at 85 years. The difference is not great up to 40 years but the weight drops rapidly after that age.

The spleen weight is greater in the white male than in the colored male at all ages. The difference is less from 25 to 50 years than after and it varies from 10 to 34 grams, about 8 to 25 percent. The same difference is found between the females of the two races, but the variations of the differences are greater in the females than in the males, the range being from 1 to 36 percent.

The great variability in the weight of the spleen may be explained in part by its evolutionary history. It is more or less a vestige, may be dispensed with entirely without serious loss to the individual, and its involution is different in different persons.

TABLE 5.

THE WEIGHT OF THE SPLEEN. AVERAGES.

20–24	99	138.2	57	110.2	30	158.6	18	123.6	55	132.5	35	103.9
25–29	92	128.6	66	109.6	23	139.0	17	119.3	63	128.2	42	104.9
30–39	231	130.5	128	109.2	87	137.1	49	128.6	124	127.3	74	96.1
40–49	268	132.5	116	101.8	108	143.3	40	102.9	133	125.8	67	101.9
50–59	254	119.4	72	97.1	109	136.0	29	98.6	121	107.4	36	86.2
60–69	221	121.6	52	88.6	110	133.7	20	102.6	79	113.0	29	82.1
70–79	102	112.0	32	79.5	52	128.2	16	96.1	38	94.4	15	60.7
80–89	28	89.2	9	71.4	9	91.7	4	66.3	14	98.4	5	75.6
90–99	2	80.0	2	65.0	1	100.0			3	73.3	2	65.0
100–	1	57.0										

A FOUR DIMENSIONAL TABLE FOR EXPRESSING THE ARRAYS OF FOUR FACTORS

In the following pages tables of this kind will be used. The table is made by a simple method using one factor as ordinate and another as abscissa, with another arrayed under each ordinate and still another under each abscissa. The arrangement in the present work is such that the differences of weight of the organs may be seen almost at a glance in relation to age, stature and conditions of nourishment.

The method may be expanded to include more than four factors, by taking out a small block from the table, adding a factor such as acute diseases and expanding the table. The groups may be divided by sex and race, or any other factor and thus include an almost unlimited number of factors. Simplification comes by segregation of any factor into small numbers, and taking individual figures instead of averages or percentages.

There is nothing new in the method of assembling and arraying data except the combination of four or more factors at the same time. The continued subdivision and segregation express in simple terms the relationship of multiple factors without confusion. The idea will be unfolded as the study progresses.

THE RELATION OF ORGAN WEIGHT TO AGE, STATURE AND NOURISHMENT

The tables referred to in the previous section will be used here beginning with the heart.

Heart. The male heart will be taken first, then the female. See Table 6. The blocks of numbers outlined with heavy black between the ages of 30 and 60 years and the statures of 160 and 180 centimeters are more nearly normal or average than the others. The group in the lower left hand corner of this block may be compared with the group in the upper right hand corner. The people represented in the former are small and young, in the latter tall and old. There are more small hearts than large in the former than in the latter. This shows that with greater age and stature the heart is larger. Taking age alone those at 30 to 39 years have 27 large hearts to 58 small ones whereas those 50 to 59 years have 47 large hearts to 26 small ones. In other words there are twice as many small as large hearts at 30 to 39 and nearly twice as many large as small hearts at 50 to 59 years of age. Taking stature alone those at 160 to 164 centimeters have 14 large hearts to 37 small ones whereas those at 175 to 179 centimeters have 26 large hearts to 63 small ones. The relative difference is about the same, therefore one would infer that

TABLE 6. MALE HEART WEIGHT, WHITE AND COLORED.

Stature	Age Nourishment Weight	20–29				30–39				40–49				50–59				60–69				70–79				80+			
		F	W	T	E	F	W	T	E	F	W	T	E	F	W	T	E	F	W	T	E	F	W	T	E	F	W	T	E
190+	400+				1		3								1				1										
	250–400		2		1		1	1				1	2		1		1		1				1						
185–189	400+		2				1		1		3				2	1			1										
	250–400		3	4			4	2			8	3	2		2	5	2		2										
	—250											1	1																
180–184	400+		6				8				6	2		1	5	1		1	3				1					1	
	250–400	2	29	5	5		21	7	7		10	8	2		8	10	1		5	7	2		2	4			1		
	—250		1	2	1			2	3				2				1				1				1				
175–179	400+		6				3	1			15				6		1		2	3			4	2			1	1	
	250–400		23	19	14		38	17	13	3	20	18	10	1	20	15	9		6	7	3		5	4	2		1		
	—250		3	8	8		1	6	4		40	2	4		1	2	3			1	1						1		
170–174	400+		5		1	1	13	2			12	3	1		12	3		1	9	5	2		5	3					
	250—400		52	27	8	1	34	26	7		24	17	10	2	22	15	12		7	16	5		11	10	5		3	4	2
	—250		5	9	7		6	8	4		4	11	4		3	1					6			2				1	1
165–169	400+		2			1	2			1	6	2			7	3		2	3	2	1	1	4	1	1		1		
	250—400	1	17	22	5		26	10	4	1	28	24	7		26	16	15		6	14	7	1	2	7			1	5	
	—250		2	5	11		1	4	11		3	4	5		3	3	2		1	2	7				1				
160–164	400+		2				3	1			4	1			4	1		1	3						1		1		
	250–400	1	22	3	2		20	8			4	12	3		17	11	4		4	6	4		6	9	1		1		1
	—250		5	6	3		1	8	4		2	3	9		4	2	2			1	1		1					1	
155–159	400+		1								3	1			1	1	1		2	1									
	250–400		5	3			4	3			6	5			5	4		1		1	1		2	2	2				
	—250			1	1				1		1	2	2		1		1			1									
150–154	400+														2				2										
	250–400		1	1				1			3	1			2	3				3									
	—250			1	1		1		1																				
145–149	250–400		1					1	1				1																
			1^{135}	1^{135}				1^{140}	1^{135}																				
	250			2				1																					
				1^{135}																									

stature has less effect than age on the heart weight, which increases as age advances. There is a difference in the weight with different statures which may be seen by comparing those at 160 to 164 centimeters with those at 180 to 184 centimeters, or with those at 170 to 174 centimeters. They may be taken at all ages or for any age group.

The weight of the heart varies with the condition of nourishment. We may take any age and stature group or all age and stature groups. The fat and the well nourished may be put together for convenience and the thin and emaciated likewise. Take the age group from 30 to 39 years and the stature group from 170 to 174 centimeters. There are 14 large organs to 6 small ones in the fat and well nourished whereas there are only 2 large organs to 12 small ones among the thin and emaciated In other words there are twice as many large as small organs among the fat and well nourished with the same age and stature and there are six times as many small as large organs among the thin and emaciated. There is thus shown to be a greater difference in heart weight with differences of nourishment than with differences of age and greater differences in heart weight with differences of age, than with differences of stature. This demonstrates that the heart is larger with increasing age, stature and nourishment.

All the groups may be combined and the differences worked out by percentages. When this is done it is found that the heart is about 20 per cent larger at 180 centimeters than at 160 before the age of 40 years with all grades of nourishment, but afterwards there is almost no difference. The heart increases in size between 20 and 60 years and decreases thereafter. The increase is about 5 per cent from 20 to 50 years, 10 per cent from 50 to 60 years and greater in the female than in the male.

There are five times as many large hearts among the well nourished males as among the emaciated, but only half as many more among the females. There are only four times as many small hearts among the emaciated males as among the well nourished whereas there are six times as many among the females. [There seems to be some sexual factor here. There are more large hearts among the males than among the females, more in the well nourished than in the thin and more in the thin than in the emaciated, when the age and stature are the same.

Emaciation seems to affect the male and female in a different way. The large organs are greatly reduced in number among the males, with a slight relative increase in the number of small and intermediate sized organs, whereas the large organs are not greatly reduced in number among the females, and there is a relative increase of the number of

TABLE 7. FEMALE HEART WEIGHT, WHITE AND COLORED.

Stature		145–149				150–154				155–159				160–164				165–169				170–174			
		A		C		A		C		A		C		A		C		A		C		A		C	
Weight	Age	20–39	40–59	20–39	40–59	20–39	40–59	20–39	40–59	20–39	40–59	20–39	40–59	20–39	40–59	20–39	40–59	20–39	40–59	20–39	40–59	20–39	40–59	20–39	40–56
550	W																								
	T																								
500	W																								
	T																								
450	W																					I			
	T																								
400	W					I								I			I						II		
	T															I									
350	W	I								I	I			I	I			II				II	I		
	T									I			I	I		I									
300	W					I				I	I	II	I	IIIII	I	I	I	II				III			
	T						I					II	I	I					I	III	I			I	I
250	W	I	II		I	IIIII	III	I	I	I	I	II	IIII	IIIII	IIII	IIIII	I	II		I		III	I	I	
						IIII								I											
	T	I	I				I	II	IIII	I		IIIII	I		I	II	I	II		III	I	I		IIII	I
200	W	I				IIII		II	II	II		II		III		IIII	I			IIII		I		I	
	T			I		I		IIII	II	I		IIII	III	I		IIIII	IIIII			IIIII	II	I		IIII	I
																IIIII	I			II					
																III									
150	W									I		I													
	T							IIIII	I	I		IIIII	II			IIIII	IIII			II				IIII	
								II								I									
100	W	I		II																					
	T			III	I			I				I	I			I									

A = Those who died of acute diseases.
C = Those who died of chronic diseases.
W = Well nourished with whom are included the fat and obese.
T = Thin with whom are included the emaciated and extremely emaciated.

small organs, with only a slight reduction of the number of intermediate sized organs. This holds true for the liver, spleen and kidneys as well as for the heart.]

THE RELATION OF WEIGHT TO ACUTE AND CHRONIC DISEASES

In Table 7 the fat and the well nourished are placed together and also the thin and emaciated, the ages are grouped from 20 to 40 and from 40 to 60 years, and the heart weights are in groups of 50 grams, from 100 to 550. Under each stature and age group the number of those who died of acute and chronic diseases is placed. Acute diseases include chiefly lobar pneumonia, typhoid fever and acute infections, and chronic diseases include chiefly tuberculosis, carcinoma, abscesses and chronic infections. The organs used had no gross pathologic lesion. It may readily be seen that the hearts of those who died of chronic diseases are lighter than those who died of acute diseases. The difference seems to be more or less irrespective of conditions of nourishment. For instance at stature 160 to 164 centimeters and heart weight of 250 grams, with age 20 to 39 years, there are 6 hearts among the well nourished and none among the thin, who died of acute diseases, and 5 hearts among the well nourished and 2 among the thin who died of chronic diseases. In general the heart weight of those who died of acute diseases is greater than those who died of chronic diseases when the other known factors are the same, but this is not always very pronounced. Differences in heart weight between those who died of acute and those who died of chronic diseases may be seen when the age and stature are the same, with the same race and sex, in either the well nourished, thin or emaciated.

Tables similar to Table 7 have been made for the kidneys and liver and they show similar differences. The differences are much greater in the liver than in the heart or kidneys. These tables were expanded in great detail so that each individual organ weight was shown in relation to race, sex, age, stature, weight, nourishment and acute and chronic diseases. The organs of those who died of acute diseases are heavier than of those who died of chronic diseases at all ages and statures in both sexes and races and under all conditions of nourishment. This was not true of every individual but the general condition admits of no doubt.

The size of the organ does not seem to be the result of acute enlargement in those who died of acute diseases, nor does it seem to be entirely the result of emaciation in those who died of chronic diseases. In emaciation, the liver, for instance, stores fat out of all proportion to the fat prevalence elsewhere and out of all proportion to the general nutrition, and it is the liver more than the other organs that shows the greatest

TABLE 8.—MALE LIVER WEIGHT, WHITE AND COLORED.

Stature	Age	20–29				30–39				40–49				50–59				60–69				70–79				80+			
	Nourishment Wgt. Gms.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.
185–189	8 = 2250														1				1										
	7 = 2000		1	1												1			2					1					
	6 = 1750						1				2	3		1									1						
	5 = 1500							1								1	1												
	4 = 1250	1																											
	3 = 1000																												
	2 = 750																												
	1 = 500																												
180–184	8		1			1	3				3				3				1	2									
	7		3	1		1	2	1			1				1				1				1	1					
	6		3								5	1	1		3				2				2						
	5	1		1	1		2		1		1	1		1		2			3	1									
	4			1			2	1	1		1					1				1	1								
	3																			1									
	2																												
	1																												
175–179	8		4	1			4			1	5			1	1				1				2						
	7			2	1		**21** 6		**9**		**14** 6	1	**10** 1		**13** 3	1	**7** 1		1	1				1					
	6		5	2	1		8	4	3		1	5			3	2			2	2	1		1	1					
	5		2	1	1		3	1	1		1	2	1		5	3		1	2	1	2		2	1			1		
	4		1					1	1		3		2		1	4	1		5	1			3	1					
	3							1	**5**		**3**		**4** 1		**1**	5	**10**		1	1				1	1		1		
	2							1	1				1																
	1																												
170–174	8		5	1			3				8	1			4	1			2				1						
	7		4				**18** 2	1	**12** 1	1	**24** 3	4	**17** 2		**23** 4		**16**	1	**20** 3		**13**		3						
	6		8	2	3		9	3	3		5		2	2	4	3	1		7	3	1		5	1	1				
	5		4	7	4	1	3	3	1		7	7	1	1	8	10	1	1	6	5	4	1	3	3					
	4		1	1		1	1	3	2	1	5	3			2	4	5	1	2	8	4		4	3					
	3			1			**3** 1		**6**		**7** 1	1	**6** 2		**5** 3	3	**12**		**4** 1	2	**18** 1			1	1		1	1	1
	2							1													3				1		1		1

165–169	8	3	1	1 2		1 2		3		2		2			
	7	3	1	**16** 3	**9**	**24**	2 **18** 1	**19** 1	**9** 1	**12** 4	**10** 1		1	1	
	6	3	2 1	5	2 1	1 10	5 2	8	4 2	1	2 1	5			
	5	4	3 1	1 4	5 1	10	6 2	7	2	5	5 1	2 3			
	4	2	3 3	2	3 3	4	3 2	5	8 2	5	5 3	5	5 3		
	3		1 1	**3** 1	**7**	**6** 2	**10** 4	**10** 5	2 **16** 4	**7** 1	3 **15** 2		1	1	1 **1**
	2				1		1			1	1 1		1		**1**
	1														
160–164	8	3			1	1		2							
	7	1 5		**12** 3	**4**	**13** 2	1 **10**	**12**	1 **12**	1 2					
	6	2	1	5	1	8	2 1	5	3						
	5	3	2	4	2	2	4 2	5	4 4		1 1	2	1		
	4	1	2 2	1	1 3	2	5 1	6	5	6	5 3	3	3 1		
	3	3		**3** 2	1 **5**	**2**	2 **11** 1	**8** 2	2 **10** 2	1	3 1				2
	2						2		1		1		1		1
	1														
155–159	8							2							
	7			1	1	1	2	1							
	6			3		1 5	3	1		1		1			
	5		1	1	1	3		3		1		1	1		
	4	4	1	2	1 1	1	1	3	2	2	1 1		1		
	3		1	2			2 1		2			1	1 1		
	2														
	1														
150–154	8 = 2250	1	1			2									
	7 = 2000														
	6 = 1750	1				1		1		1					
	5 = 1500								1	1					
	4 = 1250		1					2				1			
	3 = 1000				1		1		1	1	1				
	2 = 750														
	1 = 500														

There are 8 below 150 cm. stature, and 4 above 190.
The numbers in bold type are the totals for the small squares.

difference in acute and chronic diseases. The enlargement of the liver in tuberculosis is through fat accumulation, the liver being otherwise normal.

The question raised as to the relationship between large organs and acute diseases, on the one hand, and small organs and chronic diseases on the other is important. Possible hypotheses as suggested by Dr. Marshall may be: (a) Large organs predispose to acute diseases, (b) Large organs result from acute diseases, and (c) Large organs are coincident, accidental, with acute diseases. We know that large organs may be the result of stored material in the cytoplasm, or of pathologic material, the size may be the result of vascular conditions, or of colloid conditions, or of diffuse fibrosis, or it may be the result of actual growth above the average.

In favor of the conception that large organs predispose towards acute diseases is certain work, such as that of Opie, or of MacNider and others, showing that excessive fats are unfavorable in cases of acute injury to the liver. We also know that life insurance companies and life institutes find mortality more favorable to the thin than to the fat after 40, because of their greater longevity. It is also a recognized fact that high rates of metabolism with thinness is associated with resistance to infections, and low rates of metabolism with obesity is associated with susceptibility to infections. There are other factors that also have a bearing. The thyroid gland induces thinness when active, and when inactive the opposite condition with cretinism or myxedema ensues. The hypothysis also influences fat deposits.

Acute infections cause enlargement of the viscera by enlargement of the parenchyma cells which gives a general diffuse enlargement of the viscera. On the other hand, nearly all chronic diseases, in some way influence metabolism and there is a corresponding reduction of the storage products in the cells. As all the organs used in this study give no evidence of abnormal conditions to the naked eye we must look for something that is not shown in the organ itself except in its size.

It has been demonstrated by the author in previous researches that the hypermorph, or slender person, is more or less immune to acute diseases, whereas the mesomorph, or stocky person, is susceptible to acute diseases, and the relation to chronic diseases is the reverse. The hypermorph has small organs and the mesomorph has large ones.

The evidence while not absolute at least indicates that those persons with large organs are more apt to die of acute diseases whereas those with small organs are more apt to die of chronic diseases.

The organs in acute lobar pneumonia are larger than in any other disease, although apparently normal, and the organs in syphillis are large even when they are normal. All of these suggestions are worthy of note and await further studies for confirmation.

Liver. The liver may be studied in the same way as the heart, but it will be seen to vary inversely in size with age.

If we compare the upper left hand corner of the central block in table 8 with the lower right hand corner we find 30 livers above 1500 grams and 5 below in the former, and 24 above and 18 below in the latter. This shows that the tall young people have larger livers than the small old ones.

Taking stature alone those at 160 to 164 centimeters have 63 large livers to 39 small ones whereas those at 175 to 179 centimeters have 74 large livers to 23 small ones. Taking age alone those at 30 to 39 years have 101 large organs to 32 small ones whereas those at 50 to 59 years have 111 large organs to 72 small ones. There seems to be about the same difference for age as for stature in the proportions of the groups mentioned.

The weight of the liver varies with the condition of nourishment. We may take almost any small group with the same age and stature and the number of large or small organs will vary with nourishment. Take the group at 160 to 164 centimeters stature and 40 to 49 years of age, and the number of large to small organs is 13 to 2 for the well nourished, 7 to 7 for the thin and 3 to 4 for the emaciated, or at 170 to 174 centimeters stature and 50 to 59 years of age the proportion is 3 to 0 for the fat, 20 to 5 for the well nourished, 14 to 7 for the thin, and 2 to 5 for the emaciated. The difference between the fat and emaciated is great although the numbers are small. The small number of fat and emaciated do not vitiate the record but rather add emphasis, because in spite of the small number the relations are the same in practically all age and stature groups. There seems to be a greater difference in the weight of the liver in relation to conditions of nourishment than in relation to age or stature.

The male is not unlike the female although the number of records is smaller.

All of the groups may be combined and the averages compared by percentages in both the male and female. The livers of the well nourished male are 27.1 percent above 2,000 grams, 50.2 percent between 1,500 and 2,000 grams, and 22.7 percent below 1,500 grams; of the thin, 11.2 percent above 2,000 grams, 56.4 percent between 1,500 and 2,000 grams and 32.4 percent below 1,500 grams; and of the emaciated, 1.3

TABLE 9. FEMALE LIVER WEIGHT, WHITE AND COLORED.

Stature	Age	20–29				30–39				40–49				50–59				60–69				70–79				80+			
	Nourishment Wgt. Gms.	Fat	Well	Thin	Em.	Fat	Well	Thin	Fm.	Fat	Wel.	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.
170–174	8 = 2250									1									1										
	7 = 2000		1								1			1															
	6 = 1750				1								1		2														
	5 = 1500		2	2				2																					
	4 = 1250		3	2	2			2							1		1			1					1				
	3 = 1000		4	1	1																		1						
	2 = 750		1				1					1			1				1										
	1 = 500																												
165–169	8		1																										
	7		1				**9**		**3**		**6**						**1**												
	6		4	1		2	2			1	1					1													
	5		2	2			5	3		1	3							1		1									
	4		4	4	2	1	6	2	3		3	1			1	1			1		2						1		
	3		1	3	1		**9** 2	3	**9** 1		**4** 1		**1**		**1**		**1**		1										1
	2		2	3	1																								1
	1																												
160–164	8	1					1																						
	7		2				**11** 1		**4**	1	**3** 1		**2**		**1**		**2**												
	6		4	2		2	3							1		1			1			1							
	5		8	4	2		4	2	2		1	2					1		1				1	1					
	4	1		3			3	4			2		1		1	4	1	1	1	1				1					
	3		6	5		1	**6** 2	5	**11**		**3** 1	1	**3**	1	**4** 2	1	**7**		2	1			1	2					
	2		2	3	1			2				1				1					1								
	1																												
155–159	8									1																			
	7		3				**6** 1		**3**	1	**9** 1		**1**		**2**														
	6		2	1	1	3					2				1														
	5		5	2	3	1	1	2	1	1	3	1			1														
	4	1	2	6			2	1	2	2	2	1			3	1													1
	3		2	4	1		**5** 2	2	**8** 1		**7** 3	3	**6** 1		**5** 2	2	**3**						1	1			1		1
	2		1	2			1	2					1							2					1			1	
	1																												

150–154	8					1									
	7	1	1 1	**5**	**0**	**13** 1	**1**		**2**						
	6	1 3		2 1		1 1				1					
	5	1 8	1 1	1 1		4 5	1		2	1				1	
	4	3	1	1 4	3	7	3	1 6	2	3	1	1	1		
	3	1 5	3 1	**5**	2 **6**	**10** 2	2 **6**	**9**	1 **3**	1		1	1	1	
	2	1 2	1		1	1	1	1 1			1 1		1		
	1														
145–149	8														
	7			1											
	6							1							
	5					2			1						
	4		2								1		1		
	3	2	2	1		1	1	1			1				
	2										1		1		
	1														
140–144	8														
	7														
	6						1								
	5		1												
	4	1	2		1										
	3	1	1	1		1				1					
	2														
	1														
135–139	8 = 2250														
	7 = 2000	1													
	6 = 1750														
	5 = 1500						1								
	4 = 1250	1	1												
	3 = 1000	1					1								
	2 = 750														
	1 = 500														

The numbers in bold type are the totals for the small squares.
There are 2 lines of weights when the stature is below 135 centimeters, and 7 when the stature is above 175 centimeters.

TABLE 10. MALE KIDNEY WEIGHT, WHITE AND COLORED.

Stature	Age / Nourishment Wgt. Gms.	20–29 Fat	Well	Thin	Em.	30–39 Fat	Well	Thin	Em	40–49 Fat	Well	Thin	Em.	50–59 Fat	Well	Thin	Em.	60–69 Fat	Well	Thin	Em.	70–79 Fat	Well	Thin	Em.	80 Fat	Well	Thin	Em.
186–189	8 = 2250			1			3			1					1				2										
	7 = 2000						1	1							2						1			1					
	6 = 1750		1				1				2	1			2	1	1			1			1						
	5 = 1500		1								1	2				1	1		1										
	4 = 1250				1		1				4	1				2													
	3 = 1000										1																		
	2 = 750																		1		1								
	1 = 500																												
180–184	8		6				4				3	1																	
	7		6				1				2	1			3	1								1					
	6		3			2	5	1	1		3			1	2	1			3	1							1	1	
	5		3	1	1		3		1		9		2		1				1										
	4		5	2	2		4				3	3			3		1						1		1		1		
	3		2	1	1		1		2		1				1	1			2	1	1			1					
	2				1		2	1				1				1													
	1															2	1				1								
175–179	8		3		1		2	1	1	2	5	1		3	1				3										
	7		5				**20** 6	3	**15** 2	2	**32** 2		**9**		**13** 4	1	**8** 1						1						
	6		4	2			5		1		12	2	2			1			1					1			1		
	5		9	9	3		7	3	4		9	2	2	1	4	5			1	4	2		2	3			1	1	
	4		6	9	2		9	3	3		5	3	2		6	3	4	1	2		2		2	1				1	
	3	1	1	1	2		**14** 2	2	**13**		**11** 2		**10** 2		**8** 2	5	**21** 1		2	2	2		2	1			1		
	2		2		2		1	2			2	1	1			4			1	1					1				
	1						2		3		2		1			1	3												
170–174	8		5		1	1	3				5	6			4	1			2				1	1					
	7		3	3			**27** 8		**10**		**36** 8	1	**19** 1		**23** 1	1	**16**		**21** 5	2	**13**		2	1					
	6		13	6	1		7	3	1		12	5	1	1	12	2	2	1	6	3			2	2	1				
	5		15	4	1		8	4	2		11	3	2		5	8	2		7	7	1		3	3	1			1	
	4		7	8	6	1	7	11	1		12	5	4	2	14	8	3	1	6	7	1	1	5	1	2		2		1
	3		5	4	1	1	**15** 1	7	**28** 2		**16** 4	3	**19** 1		**27** 8	1	**19**		**12** 3	5	**23** 3		2	3			1	1	
	2		2	1			4	1	4			2	1		2	3	4		2	1	3		1	3					1
	1				1		1		2			1	2		1					2	1				1				

165–169	8	2		1 2		2 3	2	2		1		1 1			
	7	1 3	1 1	**29** 4	1 **7**	2 **27** 5	3 **15** 1	**15** 3	1 **10**	1 **11** 2	**4**	**8**	**2**	1	
	6	7	6 2	8	1	5	1	6	3 1	2 3	1	3			
	5	10	3 5	14	4 1	1 9	6 2	4	2 3	2	1 2	1 5	1	1	1
	4	7	11 2	14	3 3	6	7 4	11	5 3	4	11 2	2	2	2	1 1
	3	4	3 1	**21** 3	6 **21** 2	**14** 5	1 **19** 3	**20** 7	4 **24** 4	**8** 3	10 **33** 3	**4**	2 **13** 1		
	2		1 3	4	2 4	3	1 1	1	3 3	1	3 3	2	3 1		2 1
	1		1		1		1 1	1	2		1		3 1		1
160–164	8	1	1	1		4	1				1	1			
	7	3	2 1	**14** 1	1 **10**	**15** 1	**11**	1 **18** 3	2 **14**	3	1	1			
	6	4	3 2	5	1 1	5	4	5	3		2	1	1	1	
	5	5	3 1	7	3 4	5	4 2	9	8 1	3	1	1	1 1		
	4	1 10		7	2	6	7 3	7	4 3	4	2 2	2	1 1	1	
	3	4	3	**15** 2	4 **9**	**12** 2	4 **29** 7	**17** 6	1 **17** 2	4	6 2	2	2		1 1
	2	2		3	2	3	3 4	3	6 1	1	3 2	1	2		
	1		1	3	1 1	1	1	1							
155–159	8			1	1					1		1			
	7			1	1	1	1		1						
	6	4	1	1	2	2	2 1	2	1						
	5	3		3	2	3	2	3		2	2		1		
	4	2	2	2	1	1 2	1	3	3	3	1 1		1 3		
	3	3	1 1	1	1	2	2 2	2	1	1	2 1				
	2		1 1	1			1	3	1			1	2		1
	1	1			1 1				1						
150–154	8 = 500				1										
	7 = 450	1						1							
	6 = 400		1					2							
	5 = 350				1	1	1	1							
	4 = 300		2			1	1	1	1						
	3 = 250		1		2				1	2					
	2 = 200		1	1		1	1	2		1					
	1 = 150				1						1 1				

The numbers in bold type are the totals for the small squares.
There are 2 kidney weights when the stature is below 155 centimeters, and 1 when the stature is above 190 centimeters.

TABLE 11. FEMALE KIDNEY WEIGHT. WHITE AND COLORED.

Stature	Age	20–29				30–39				40–49				50–59				60–69				70–79				80+			
	Nourishment Wgt. Gms.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.	Fat	Well	Thin	Em.
175+	6	1					1		1		1																		
	4		1			1	1				1																		
	2				1															1									
170–174	8 = 500																												
	7 = 450			2													1												
	6 = 400						1											1	1										
	5 = 350+		1	1						1	1	1	1							1									
	4 = 300		2				1	2			2			1							1		1						
	3 = 250			1			1	3		1			1		3						1								
	2 = 200				1				1																				
	1 = 150+						1																						
165–169	8						2																						
	7		1				**10** 1		**2**		**2**																		
	6		2			1	2								1	1						1							
	5		2		1	2	2	1	1		2									1									
	4		5	3	1		2	5	1	1	1	1	1	1				1					1						
	3		1		1		**6** 3	4	**12** 1	1	**4** 1	1	**3**	1	2	1			3		1								
	2		1	2	1			1							1		2				2		1						
	1		2				1									1													1
160–164	8	1									2	2								1									
	7		1	1			**4**		**5**		**4**		**8**		**5**		**4**							1					
	6		1			2		3				1		1		2													
	5	2	5	4	2		2	2			2	3	2	2	2	2		1	1	1			1						
	4		10	2	1	2	6	3	1		1	3	4	1	2	1		1	2			1		1					
	3		8	8	1		**15** 4	3	**14** 1	2	**7** 3		**10**	1	**9** 2	7	**9**		1	2				3					
	2		2	1		1	1	5			1	1	1	2	1		1		1		1		2	1					
	1						1		1			1							1						1				

155–159	5	1	2	1 4	2	1 5		1 1							
	4	5	4	1 4	6 2	1 2	4 1	1 6	1 7			2			
	3	1 1	6 1	**11** 4	3 **13** 1	2 **9** 3	6 **14**	**9** 1	2 **7**	1	1		2		1
	2	3	2 1	2	1	1	2		3		2	1	1 1	2	
	1		2				1	1			1 1				
150–154	8	1													
	7			2 **9**	**1**	**3**	**4**	**3**	**3**	1					
	6	1 1	2 1	1	1	1 1			2	1					
	5	1 2	3	2 4		1	3 1	1 2	1	1 1	2	1			
	4	5	3 2	2 7	2 1	3 3	1 1	2 3	2	1	1	1		1	
	3	2	2	1 **14** 3	1 **11** 3	1 **16** 3	3 **10**	**14** 4	1 **7**	1		1	1 1		
	2	1 4	1	1	4	1 3	4 1	1	1 2	2	1 1		2 1		1
	1	1	1			1 1		1 3	1	1	1	1	1 1		1 1
145–149	8														
	7	1		1			1								
	6	2		1			1								
	5				1				5						
	4	2	2	1	1 1	1 4	1	1 3							
	3	1	1			1	1			1	1		1		
	2							1	2						
	1						1				1		1		
140–144	8														
	7														
	6														
	5				1		1								
	4		1	1		1	1	1		1					
	3	1	1		1	1			1	1					
	2														
	1												1		
135–139	8 = 500														
	7 = 450														
	6 = 400														
	5 = 350										1				
	4 = 300	2						1 1							
	3 = 250														
	2 = 200						1								
	1 = 150 +														

The numbers in bold type represent the sums of the numbers in the small squares.
There are 13 kidney weights in the stature groups below 135 centimeters.

percent above 2,000 grams, 54.0 percent between 1,500 and 2,000 grams; and 44.7 below 1,500 grams. The livers of the well nourished females are 2.8 percent above 2,000 grams, 34.9 percent between 1,500 and 2,000 grams, and 62.3 percent below 1,500 grams; of the thin, 1.3 percent above 2,000 grams, 17.4 percent between 1,500 and 2,000 grams, and 81.2 percent below 1,500 grams; and of the emaciated, 0.0 percent above 2,000 grams, 29.0 percent between 1,500 and 2,000 grams, and 71.0 percent below 1,500 grams. There are twenty times as many large livers among the well nourished males and females as among the emaciated, but there are only twice as many small livers among the emaciated males as among the well nourished and there are about the same number among the emaciated as among the well nourished females.

The differences with increase in stature and age when worked out in a similar way show that the liver weight is about 15 percent greater at 180 centimeters stature than at 160, and that the liver decreases in size continuously from 20 years onward, about 5 percent from 20 to 50 years, 10 percent from 50 to 80 years, more thereafter and more in the female than in the male.

There are more large livers in the male than in the female, more in the well nourished than in the thin and more in the thin than in the emaciated with the same age and stature.

Kidneys. There seems to be little difference in the weight of the kidneys with varying statures and ages in the male, but there is a difference in relation to nourishment. Any age and stature group may be taken and this difference will be seen. For instance at ages 30 to 39 and statures 170 to 179 there are 26 large livers to 13 small ones in the well nourished, 7 to 19 in the thin and 3 to 9 in the emaciated, and at age 50 to 59 and stature 175 to 179 there are 4 large livers to no small ones in the fat, 9 to 8 in the well nourished, 7 to 13 in the thin, and 1 to 8 in the emaciated.

All the groups may be combined and the averages compared by percentages. The well nourished male has 33.3 percent over 400 grams, 58.2 between 250 and 400 grams, and 8.5 percent below 250 grams; the thin has 26.1 percent over 400 grams, 62.2 between 250 and 400 grams, and 11.7 below 250 grams; and the emaciated has 15 percent over 400 grams, 66 percent between 250 and 400 grams, and 19 percent below 250 grams.

The condition in the female is similar to that in the male. When the small blocks in the tables are removed and expanded in detail the differences are seen clearly and readily. In this way all the groups of organs as given in the first part of this paper may be compared. It will be seen then that the pathologic organs are larger than the near normal, the near

normal are larger than the normal, and the male than the female. The size varies directly with the condition of nourishment in each group.

THE RELATION OF WEIGHT TO TYPE

Following the study of 1,200 postmortems, and 1,500 patients, it was found that the Hypomorph and Mesomorph, or infantile and broad types, are susceptible to diseases of the tissues derived from mesoderm such as heart disease, aneurism and other diseases of the arteries and veins, and diseases of the kidneys, bones and muscles as well as acute diseases. The Hypermorph was found to be susceptible to diseases of the tissues derived from the ectoderm and entoderm, such as pulmonary tuberculosis, alimentary, skin and nervous diseases, and chronic infections. In 1916 a method was devised which represents the difference in size of an organ in relation to any factor such as stature, sex or type.

The size of the organs was found to vary with stature 1 point for the heart, 4.9 for the liver, 4.9 for the spleen and 3.2 for the kidneys. The size varied with age 5.2 for the heart, 3.5 for the liver 7.7 for the spleen, and 0.0 for the kidneys. The spleen is thus shown to vary more than the other organs through the influence of age and stature. The ratio of difference in organ weight between the Hypermorph and Mesomorph was found to be 19.0 for the heart, 6.1 for the liver 4.7 for the spleen and 4.1 for the kidneys. This difference is greater than the racial difference between the white and colored male, which is 0.4 for the heart, 1.0 for the liver, 2.0 for the spleen and 0.1 for the kidneys. The size of the organs varied by sex in the negro 14.4 for the heart, 2.9 for the liver, 2.0 for the spleen, and 3.4 for the kidneys. The heart varies more than the other organs by type and sex, but the spleen varies more by race.

The Hypomorph and Mesomorph have large organs and the Hypermorph has small organs.

Summary

The organs are larger in the male than in the female when the age, stature and condition of nourishment are the same.

There is not much difference in organ weight between the white and the colored except for the spleen. The spleen of the American Negro is smaller than that of the American White, and the difference varies from about 8 to 25 percent.

The organs vary with age in different ways, the heart increases, the kidneys remain about the same, and the liver and spleen decrease in the adult until late in life when all of the organs decrease in size.

The organs vary with stature, the small having small organs and the tall large ones.

The organs vary with nourishment, decreasing in size from the fat through the well nourished and thin to the emaciated.

VARIATION WITH AGE

The heart grows larger up to about 20 years when it remains at about the same weight until about 30 after which it increases in size to 60 years when it becomes gradually smaller until death. The heart of the female increases in size about 5 percent more than that of the male.

The liver grows larger up to about 20 years, after which it decreases in size continually until at 90 years it is only about two-thirds its size at 20. The decrease is proportional to the increase in size of the heart and synchronous with it: About 5 percent from 20 to 50 years, about 10 percent thereafter, and greater in the female than in the male.

The spleen increases in size to 20 years or earlier, after which it decreases at a slightly faster rate than does the liver, although they are almost parallel. The joint function of the spleen and liver in handling the broken down blood corpuscles may have something to do with the rate of decrease in size. The inverse ratio of heart and spleen-liver size with age is also suggestive. There is a damming of blood into the liver and spleen when the heart is overworked, and this increases with age.

The kidneys remain about the same size from 20 to 40 or 50 years, but decrease in size thereafter.

VARIATION WITH STATURE

The heart of the well nourished, thin and emaciated is about 20 percent larger at 180 centimeters stature than at 160, before 40 years, but afterwards there is little difference. The liver is about 15 percent larger at 180 centimeters than at 160. The kidney weight varies little with stature. The spleen weight seems to vary more with stature than the kidneys, and there are more extremely small spleens with small stature and more extremely large spleens with tall stature than for the heart, liver or kidneys.

VARIATION WITH NOURISHMENT

Emaciation seems to affect the liver more than the heart, and the heart more than the kidneys. The result is to reduce the number of large organs rather than to increase the number of small ones.

The changes are greater in the male than in the female. The number of large organs is greatly reduced in the male but not in the female, and

there is a slight increase in number of small organs in the male, which is larger in the female.

VARIATION WITH DISEASE

When the diseases were grouped into acute and chronic, the organ weights separated themselves into heavy for acute diseases and light for chronic. The separation was distinct, the spread of organ weight little, the group homogeneous, when the age, stature, race, sex, and condition of nourishment are all the same. This suggests that those persons who have large organs are susceptible to acute diseases, whereas those with small organs are susceptible to chronic diseases.

FOUR DIMENSIONAL TABLES

Tables were constructed to show four or more factors in relation to the weight of the organ. These were combined or extracted in such a way as to show sexual and racial differences with the same age, stature and nourishment, and either acute or chronic diseases as the primary cause of death.

AGE CHANGES IN PIGMENTATION OF AMERICAN NEGROES[1]

MELVILLE J. HERSKOVITS

Studies of pigmentation which have been made in the past can be classed, as far as method employed is concerned, into those which have used color scales of one type or another, and those which have attempted to develop a way of determining pigmentation quantitatively. The first class comprises practically all of the investigations which have been made, and these have employed such color charts as the von Luschan color scale, or colored papers, and the like. The other method, which I have used, has, to my knowledge, been used on Negroes only in studies made by Davenport[2] and Todd and van Gorder.[3]

This method attempts to determine skin color quantitatively, instead of employing the qualitative method characteristic of the use of charts. The device by which this result is obtained is a small top, originally made to teach kindergarten children the principle of color mixture, and which is manufactured in standardised form by the Milton Bradley Company. The top comes with a number of colored disks, and from these are selected the black, the red, the yellow, and the white. The red, unfortunately, is darker than spectrum red, and must be checked with such a work as Ridgeway's[4] to obtain the true color value of it, which is seen to be red, 41%, black, 59%. This necessitates working over the readings after they have been taken, and subtracting 59% of the value of the red segment made by the disk of that color from its reading, and adding this amount to the black. It was the failure to check up on the extent to which the colors of the disks are true colors, and the resulting failure to make the necessary corrections, that makes the conclusions reached by Davenport untenable, and that makes comparison with his work difficult. Todd and van Gorder, who discovered this error in the red disk of the top, have allowed for the error in their paper, and their figures are the corrected ones.

[1]A paper read at the annual meeting of the American Anthropological Association, New Haven, Connecticut, December 29th, 1925.

[2]Charles B. Davenport, Heredity of Skin Color in Negro-White Crosses. Carnegie Institution, Washington, 1913. Notes on Physical Anthropology of Australian Aborigines and Black-White Hybrids, Am. J. Phys. Anthrop., 1925, viii, pp. 73–94. The material employed in this last paper constitutes such a small series as to make any conclusions to be drawn from it practically worthless for purposes of comparison.

[3]T. Wingate Todd and Leona van Gorder, The Quantitative Determination of Black Pigmentation in the Skin of the American Negro, Am. J. Phys. Anthrop., 1921, iv, pp. 238–260.

[4]R. Ridgeway, Color Standards and Color Nomenclature. Washington, 1912.

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The paper disks are fastened on the top by means of a small wooden catch which holds them, and there is then presented a surface which, if its circumference be taken as 100, presents segments of the disks of the four colors which occupy various proportions of the total. The circumference of the cardboard base on which the disks rest is divided into 20 units, each of which can be counted as 5% of the total. The disks are adjusted by means of a forceps in order to obviate discoloration of the disks thru contact with the fingers. Nevertheless, there is a tendency for the lighter ones to become darker with use, and therefore the tops are changed after from 12 to 15 readings.

The skin which has been studied is that of the upper outer arm, a spot which while easily reached, is not readily exposed to the sun and the resulting darkening of the skin thru sunburn. The procedure was as follows: the individual measured was asked to place his arm on a table on which the top was spun. The upper arm, just under the sleeve, was covered with a white paper in which a hole had been made. Another rested on the table and on this the top was spun. Therefore, it will be seen that there was little error due to having the top some distance from the skin with which it was compared, and that there was no error introduced through influence on the eye of other colors, since there was only white between the skin and the top. The spinning of the top with the adjusted disks gave, of course, the proper color combination.

The observational error might be thought to be great. Todd and Van Gorder[5] feel that observational error should come within 5%, although their work was carefully controlled in the laboratory as to lighting and other conditions, which obviously are unobtainable when working with the living. I remeasured 48 boys to obtain my own observational error, and in doing so, I consciously attempted to make this remeasuring no more favorable than the least favorable conditions under which the actual measurements were taken. That is, the boys were remeasured on different days, when the light was different, and some tops were used which were quite new, others which had been used more than I usually use them. Even with all these sources of error, the mean observational error for the four colors were:

Black	(N)[6]	3.21%
Red	(R)	2.15%
Yellow	(Y)	1.19%
White	(W)	1.44%

[5]Op. cit., p. 246.

[6]In the remainder of this paper, N, R, Y, and W will stand for the respective colors which they represent in this table.

Although this method does give pigmentation quantitatively, there are many of the difficulties inherent in it which also are true of the use of color charts. While it may be said that the colors on the charts are arbitrarily chosen, the same is none the less true of the four color disks which are used, and which, really, have little relation to the actual colors which go to make up pigmentation. The advantage is in the finer degrees of shading which may be made, and the fact that, an observation having been made, what it represents is accurately known in terms of the colors used. There is also the fact that, in essence, any measurement of pigmentation is a matter of judgment, and the subjective element will vary largely with the different individuals who do the measuring. The change of color with change of speed of the tops, and other defects of like nature which are also present, and inherent in the method, are taken care of and included in the observational error. At the same time, in spite of all these difficulties, there can be no question that the results do give the most satisfactory index of skin color values which has been devised, to date and, in the present case, the measurements having all been made by me, the values for the groups which are to be discussed may be directly comparable.

The means and variabilities for the age groups which have been studied are given in Table 1. The numbers of cases in the 5½ and 17½ year

TABLE 1.

PIGMENTATION CHANGES WITH GROWTH. NEW YORK CITY COLORED BOYS. MEANS ± SIGMAS.

Age	No.	N (%)	R (%)	Y (%)	W (%)
5½	22	64.23±14.7	12.91±2.87	11.00±4.59	12.68±8.66
6½	55	66.07±15.3	12.15±2.85	10.78±5.91	11.22±8.24
7½	101	69.97±11.9	11.93±2.88	9.26±4.67	9.11±4.89
8½	124	69.34±13.34	11.89±3.21	9.38±4.74	9.73±7.18
9½	131	70.71±12.96	11.65±3.17	7.46±3.25	9.00±6.85
10½	134	70.64±11.4	11.84±2.86	8.97±4.59	8.42±5.38
11½	140	72.56±10.2	11.54±2.86	8.17±3.87	7.68±4.39
12½	126	70.90±12.33	12.01±3.09	8.70±4.45	8.58±5.96
13½	141	75.30± 8.31	11.00±2.74	7.10±3.03	6.59±4.21
14½	117	72.24±10.86	11.79±3.10	8.14±3.77	7.99±5.04
15½	80	74.14±11.7	10.79±2.94	7.39±3.78	7.64±6.51
16½	29	74.28±10.34	10.48±2.46	7.45±3.75	7.72±5.17
17½	12	74.08±——	11.25±——	8.00±——	7.50±——
HU and NYC adults	534	66.40±13.85	12.37±2.82	10.79±4.54	10.37±8.33
WRU adults	94	82.79± 6.11	7.61±2.51	4.98±2.25	4.57±2.41

classes are too small to make these two groups of any great significance, except that they fall in with the general curve of change in skin color in convincing fashion. That the change which is shown from light to

dark with increasing age is not unexpected is seen from other studies which have been made; Davenport[7] cites studies which have been made on newly born Negro children, all of which agree as to their light color and increasing darkness, while the analysis of his data for the parentage of N (uncorrected) shows an increasing darkness through the 40th year.[8] Todd and Van Gorder obtained the same result, their table for corrected values of N being[9]

Age	No.	%N
0–9	4	75
10–19	8	87
20–29	30	85
30–39	26	82
40–49	19	83
50–59	2	76
60–69	5	76

Of course, the number of the skins which were measured for color is not as large as the number of persons measured in my series, while the age grouping is much rougher. But all indications go to show that the pigmentation of the Negro becomes steadily darker with age.

If we analyse the figures given in Table 1, we see that the amount of change is relatively great. There is a steady increase in the percentage of N (if we except the 11½ year old class) from 64% to 74%, thus showing a steady darkening of the skin. For the other colors we find a corresponding change as would be expected. There is a slight though regular decrease in the red, a larger and somewhat less regular one in the yellow, and a decisive decrease in the white with increasing age. The nature of the distribution curves may be briefly discussed. In all curves for an unselected Negro population that I have taken, and all that I have seen taken by others, there is a distinct skewness. In the case of the black, yellow and white elements, this is particularly true, although the curves for the red are approximately close to the normal curves. This is probably due to the fact that this curve represents the distribution of blood color, which is perhaps not determined by racial differences. The large skewness in the black will be discussed below. That of the yellow can be explained by the same explanation given for the black, but that of the white, which exhibits invariably skewness of a type more pronounced than that of any of the other colors, can perhaps best be explained by the difficulty in accurately detecting differences between large values of White in the spinning top. That is, in the color resulting from spinning a top with 2% and 4% of white the difference is at once apparent, but

[7]Heredity of Skin Color in Negro-White Crosses, p. 4.
[8]Op. cit., p. 7 (Table 1).
[9]Op. cit., p. 259.

that between 22% and 24% is not noticeable at all. This would tend to string out the curve toward the upper values, resulting in the especially pronounced skewness.

When we come to a consideration of the black element, we find that the skewness is perhaps due in part to the ethnic composition of the American Negro. Measurements and genealogies taken on 538 students at Howard University in Washington, D. C., and on adult males in New York City, give the following percentages of individuals of various amounts of white admixture.

N	All Negro	109	20.3%
N(I)	Negro with Indian	36	6.7%
NNW	More Negro than White	129	23.8%
NNW(I)	More Negro than White with Indian	51	9.6%
NW	About the same amount of Negro and White	95	17.7%
NW(I)	About the same amount of Negro and White with Indian	57	10.6%
NWW	More White than Negro	30	5.6%
NWW(I)	More White than Negro with Indian	31	5.7%

Now this, obviously, would effect the extent to which a large percentage of any sample of American Negroes would be expected to be quite dark, and we find that the means for the four colors of the disks used in taking skin color vary with the amount of Negro and White ancestry as follows:

Class	N (%)	R (%)	Y (%)	W (%)
N	75.49±10.34	10.80±2.93	7.76±3.57	6.00± 5.24
N(I)	74.86± 9.51	10.97±2.61	8.17±3.64	5.97± 4.02
NNW	68.26±11.58	12.45±2.79	10.49±4.32	8.68± 5.80
NNW(I)	70.32±10.39	12.18±2.94	9.74±3.98	7.66± 4.69
NW	61.24±12.01	13.20±2.33	12.98±4.07	12.90± 8.21
NW(I)	59.44±11.20	13.61±2.18	13.61±4.38	13.48± 7.33
NWW	48.70±13.67	13.93±2.25	14.30±4.11	23.00±10.37
NWW(I)	56.90±14.39	13.39±1.68	13.35±3.06	16.97±10.79

This, then, may contribute in large part toward the skewness manifest by the frequencies for the black in the top. And if, as has been claimed, the yellow is obscured by the presence of much black, this explanation would fit the skewness of this color also.

Another point, however, of interest somewhat outside the field of this general topic of change in pigmentation with age is furnished by the results which have been obtained thru the study of skin-color in these groups. In Table 1 there have been given, besides the means for the age-groups of Negro boys, that for the entire series which comprises the Howard University students and the New York City adults. In the course of things,if these two series represented the same skin-color types, the mean for the adult group would be expected to be, for the N, greater than that for any of the age means, or, in other words, to continue the progression toward deeper skin color with increasing age. The opposite

would be expected for the other three colors. But, on the contrary, nothing of the sort is seen. Instead, there is a decided drop for the mean for N of the adult series, when compared to those of the boys, and higher values for the other colors. The mean for these values for the Western Reserve Negro pauper material, composed of adults measured by Todd and Van Gorder, is also given. It will be seen that here the mean for the N is quite a bit higher than the highest for N of the New York boys. Some of this excess may be put down to the effect of darkening of the skin after death, although not all. In the main, though, it may be said to agree with the curve which would be expected from adults to a greater extent than does that of the Howard material, even allowing for changes in pigmentation due to death.

I do not doubt but that this is a striking indication of the color distinction present among the American Negroes, which I have already discussed elsewhere.[10] The hypothesis that the lighter Negro holds a socially strategic position within the Negro community has seemed very plausible to me, but it was not until I tabulated this material that the confirmation in this striking fashion became evident to me. That is, the Negro boys represent an unselected portion of our American Negro population to a highly acceptable degree. Due to the migrations, it is believed that it represents not only the northern Negro but the southern as well, and that in addition there is a representation of West Indian Negroes who have been migrating to New York in the past few years. It is, therefore, as I have said, a sample thoroughly representative. However, it has been held that the lighter Negro has the better economic opportunity, within the Negro community, and this would lead us to expect that a group where so much depends on leisure as does the opportunity for higher education would reflect this phenomenon. That there is this distinct drop in the percentage of N in the pigmentation of these university students, therefore, is not surprising in the light of this social situation of the lighter Negroes.

There is also one other conclusion which may be drawn from comparing these results. It will be remembered that in the discussion given above of the percentages in the male adult sample of Negroes of various amounts of Negro and White blood, 20% roughly, gave themselves as all-Negro. It is believed that the validity of these genealogies is not to be doubted, for in trait after trait which was measured, the means for the group having all-Negro ancestry was close to the African means, and startlingly contrasted with those groups giving themselves as having

[10]The Color Line, American Mercury, 1925, vi, pp. 204–8. See also "The Paradox of Color," by Walter F. White in "The New Negro," pp. 361–369.

more White than Negro ancestry, for example. But it is believed that the result of this comparison should cause us to revise any estimate of the percentage of full-blooded Negroes which we might make when applying the results to the Negro population in the country at large. If there is a color selection, then since color varies on the average with the amount of Negro blood represented in groups (though this does not apply except very roughly to individuals), it is obvious, that, since the New York boys' sample gives a more adequate representation of the Negro population as a whole than does the adult sample, the percentage of all-Negro class is too small. I feel, on the basis of these results, then, that there is probably a percentage of nearer 30% of the American Negroes who are without White or Indian ancestry, rather than the 20% which came out of the genealogies I obtained.

As results of the study which has been undertaken here, then, we can say

1) That although there are many defects to be seen in the use of the color top, results taken by one individual may be compared as indicating relative darkness of pigmentation;

2) that if we compare the percentages of black in the top for groups of Negro boys of various ages, we find that there is a gradual darkening with increased age; a result which agrees with the findings of earlier investigators;

3) that if the curve of change in pigmentation with increased age be attempted to be continued by the use of the male adult series which I have gathered, this is not possible, since there is a decided drop which is entirely unexpected, and

4) this drop is due to the social selective force of the social advantage accruing to Negroes with lighter skins in their own community.

SHORTENING OF THE NASION-BASION LENGTH IN THE WHITE RACES

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Craniometric Studies, No. 2

The first study (1) of this series dealt with the correlation between the nasion-basion length and the maximum glabella-occipital length. During the progress of that investigation it was noted that the mean nasion-basion length was shorter in the White races than in the Negro races. Moreover this condition was found to be consistent for the males and females of both races. As a matter of fact the difference proved to be very slight but its definite character at once arrested attention.

It would naturally be argued that in the process of evolution of the skull of the higher races there would require to be an increase in the dimensions of the cranial base concomitantly with the expansion of the roof, in order to provide accommodation for an increased size of brain. From that view point the shortening of the nasion-basion line appeared to be more and more of an anomaly.

The collection of White and Negro crania in the Hamann Museum, Western Reserve University, was again made use of in the present research, and these were divided, as before, into four groups—Male White, female White, male Negro and female Negro. The number of crania utilized was—358 male White, 51 female White, 153 male Negro and 37 female Negro. As the Hamann collection expands, the writer has obtained permission from Professor Todd to supplement the number of the female crania, so as to make these correspond to the male series and thus render the results more balanced in character. He desires to record once more his sincere gratitude to Professor Todd for the free use of that valuable material.

TABLE 1.

To Show That the Mean Nasion-Basion Length is Shorter in the White Races than in the Negro Races, This Result Being Consistent for the two sexes.

	Crania	Mean nasion-basion length		Crania	Mean nasion-basion length
Male Negro	153	100.5 mm.	Female Negro	37	95.9 mm.
Male White	358	100 mm.	Female White	51	94.8 mm.

It will be noted that the difference in the male series is only .5 mm., but is definitely greater in the case of the females. It is interesting to note that the result is consistent for the two sexes, in spite ot the very

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small number of the female crania, as compared with the vast size of both male series.

These results encouraged the writer to make further investigations upon the subject and for this purpose he had access to the crania of the Canadian Arctic Expedition (2), the Catalogue of the Royal College of Surgeons Museum (3), and to a valuable paper by Schultz (4) on the basis cranii. In the latter memoir are given measurements of the nasion-basion line in various races, and the writer decided to choose out of the list the European crania for comparison with the American White, and the West African Negro crania for contrast with the American Negro material. He was much interested and likewise gratified to note that the measurements given in Table 1 of Schultz's memoir corroborated the results obtained from a study of the Hamann Museum crania. For example, the nasion-basion length was definitely longer in the West African Negro, as compared with the European, and moreover these results were consistent for the two sexes.

TABLE 2.

(Compiled from Schultz's Memoir). To Show that Nasion-Basion Length is Greater in The West African Negro than in the European White, This Condition Being Consistent for the Two Sexes.

	Mean nasion-basion length		Mean nasion-basion length
West African Negro Male	102 mm.	West African Female Negro	99 mm.
European Male White	100 mm.	European Female White	91 mm.

It will be noted that here, as in the case of the Hamann Museum crania the difference is much more marked in the case of the female crania (see Table 1). It may be further observed that the usual wide ranges of variation existed in these cases too. For instance the maximum nasion-basion length in the West African Negro males was 112 mm. and the minimum 95 mm., and for the West African Negro females 110 and 86 mm. In the European male and female crania the corresponding figures were 107, 94, 96 and 87 mm. respectively.

A perusal of the Royal College of Surgeons Museum Catalogue (3) elicited much valuable information on this matter. The writer chose the English and Italian groups of crania, as representative of northern and southern European racial types. In the Italian group 75 male crania were available and the mean nasion-basion length for these proved to be 100.4 mm., which was just below the mean for the American Negro male, and well below that for the West African Negro male. The racial range of variation here was from 111 mm. to 91 mm.

An examination of the English group showed that only 23 crania were available as indisputably male, so that the result is not so representative.

In this case the racial range of variation was from 109 to 96 mm. The mean nasion-basion length yielded by this group was 101.4 mm., which was below the mean of the West African male Negro but higher than the American male Negro mean.

A study of the measurements of the African Negro crania in the same catalogue proved likewise very instructive and gratifying. Of this collection 108 crania were unequivocably male and 37 female. In the extensive male series only 28 skulls fell below the 100 mm. level, and the range of variation when calculated was found to extend from 113 to 91 mm., with a mean measurement of 102.1 mm., which proved to be higher than the American Negro mean and the mean Negro measurement given in Schultz's memoir. In the case of the females the range of variation was from 103 to 85 mm., with a mean of 97.1 mm.

The outcome of this part of the investigation is, that the three Negro groups, taken in conjunction, exhibit a mean nasion-basion length definitely higher than that existing in the White races.

The Eskimo skull evidently occupies a unique position, so far as the nasion-basion length is concerned, for in this race it appears to reach its maximum dimensions. For example the writer found that the mean showed the high figures of 106.7 mm. in the male and 98.8 mm. in the female Eskimo crania of the Canadian Arctic Expedition (2). Here the racial variations were from 111 to 102.5 mm. in the males, and from 104 to 94 mm. in the females. These observations were substantiated by a study of the measurements of Eskimo crania given in Schultz's memoir (4), where the nasion-basion length varied from 115 to 101 mm. in the males, with an exceptionally high average of 108 mm., and from 109 to 98 mm. in the females, with an average of 102 mm.

Further confirmation of these results was furnished by the Eskimo crania of the Royal College of Surgeons Museum (3). In this collection the racial range of variation was from a very high maximum of 117 to a minimum of 97 mm. in the males, with a mean dimension of 106.1 mm., and in the females from a maximum of 104 to a minimum of 94 mm., with an average of 99.7 mm. In the male series the nasion-basion length dropped below 100 mm. in only two instances.

These consistent results, obtained from three distinct collections of Eskimo crania, stimulated speculations as to the causative factor of this condition. It might be suggested for example, that the well marked dolichocephaly which exists in the Eskimo cranium, might be the reason and the same argument might with equal justice be advanced in the case of the Negro skull, but it may be pointed out that many of the white races are likewise dolichocephalic, which puts a veto on this hypothesis.

In the case of the Eskimo it may be that his unique environment, or his specialized methods of mastication, or a combination of both represent the main controlling influence. However, it is impossible to speculate further in this matter with the present data at our disposal.

TABLE 3.

To Demonstrate the High Average Measurements Exhibited by the Nasion-Basion Length in Eskimo Crania Chosen from Three Distinct Collections.

	Eskimo crania of the Canadian Artic expedition	Eskimo crania in the R. C. S. Catalogue	Eskimo crania from Schultz's memoir
Male	106.7 mm.	106.1 mm.	108 mm.
Female	98.8 mm.	99.7 mm.	102 mm.

The close correspondence of the measurements, both male and female, yielded by the crania of the Canadian Arctic Expedition and the Royal College of Surgeons Museum Catalogue is noteworthy.

We are now faced by the problem of explaining this shortening of the mean nasion-basion line in the White races. As a matter of fact, one possible clue is found in a paper recently published by the writer (5). In this it was pointed out that the "main angle of cranial flexion" is larger in the American Negro than in the American White, this condition being moreover, consistent for the two sexes. The figures obtained were 137° in the female Negro, 134° in the female White, 135° in the Male Negro and 131.5° in the male White. This angle is subtended by the nasion-basion line (see Fig.) and it is therefore clear that the smaller the angle the shorter will be the nasion-basion length, conditions which certainly hold in the American White. In comparing any two individual cases the two sides enclosing the angle would have to be regarded as constant. The appended diagram illustrates this point.

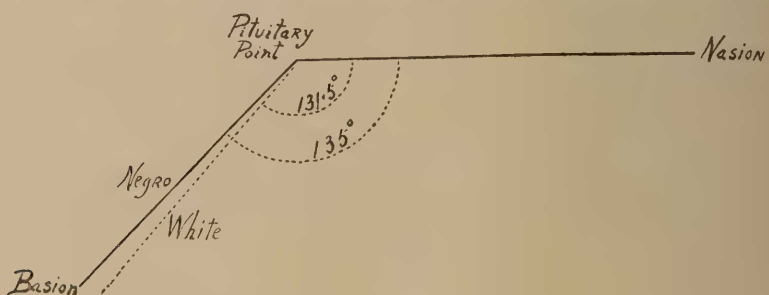

Fig. 1. To show that the shortening of the nasion-basion length in the American White is due to a reduction in the size of the "main angle of cranial flexion."

During the process of development of cranial flexion it is clear that both the pituitary-nasion and the pituitary-basion planes will be

affected, but for purposes of demonstration, the pituitary-basion line is alone represented as being moved.

The observations embodied in this paper have been advanced as a possible explanation of a rather interesting condition, in the hope that they may stimulate further speculation on the subject. It may be that there are other factors at work which have been overlooked by the writer, and he will therefore be very glad to welcome further suggestions from craniologists on this matter.

Summary

1. The nasion-basion length is shorter in the American White than in the American Negro.

2. This shortening was found to be consistent for the males and females of both races.

3. These results were confirmed by a study of the crania of the Canadian Arctic Expedition, the Catalogue of the Royal College of Surgeons Museum, and data furnished by a paper on the basis cranii by Schultz.

4. The Eskimo skull occupies a unique position, so far as the nasion-basion length is concerned, for in this race it appears to reach its maximum dimensions.

5. The writer's "main angle of cranial flexion" is larger in the American Negro than in the American White. This angle is subtended by the nasion-basion line, and it is therefore clear that the smaller the angle the shorter will be the nasion-basion length, conditions which certainly hold in the American White.

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THE CORRELATION BETWEEN NASION-PITUITARY AND MAXIMUM GLABELLO-OCCIPITAL LENGTH OF THE SKULL

Craniometric Studies, No. 3

The first study of this series (1) dealt with the correlation between the nasion-basion length and the maximum glabella-occipital length. The results that were obtained showed the existence of a definite correlation between these two cranial measurements. In the present communication another basal length, the nasion-pituitary, has been chosen for comparison with the maximum glabella-occipital length. As the nasion-pituitary length has not been utilised in any previous research work, so far as the writer can ascertain, it will be necessary first of all to make mention of the pituitary point. The position of the latter has been fully defined by the writer in a previous communication (2), in which he gave full, and what he considered, cogent reasons for selecting it as a craniometric point. The consistent results yielded by that research proved that the pituitary point possessed a degree of stability and reliability by no means inconsiderable.

For the purposes of the present research the collection of human crania in the Hamann Museum, Western Reserve University, was again utilised, and the writer desires to record once more his sincere gratitude to Professor T. Wingate Todd for the free and unrestricted use of that valuable material. The crania were divided as before, into four groups—male White, male Negro, female White and female Negro, and the material that was utilised consisted of 358 male White, 153 male Negro, 51 female White and 37 female Negro—599 crania in all.

As a result of my first craniometric study, I received an interesting and indeed gratifying letter from Dr. Adolph H. Schultz in which he stated—"I was very much interested to see your recent paper. In my inaugural dissertation (3) (for the Degree of Ph.D., at the University of Zürich) I treated the same problem in a slightly different manner, and I was very glad indeed to note that your results agreed perfectly with my own findings."

I very much regret that I did not previously know of the existence of Dr. Schultz's valuable and elaborate memoir, which was published in Zürich in 1917. However, it is sometimes an advantage when two investigators chance to work along parallel lines unknown to one another, particularly when the results happen to agree closely, as in the present instance. It will be necessary therefore to comment at length upon Schultz's results first of all. He conducted his researches upon the

crania of divergent types such as Chinese, Ancient Egyptian, European, Eskimo, West African Negro and Aboriginal Australian. He found that the most favourable correlation between the nasion-basion length and the maximum glabella-occipital length, viz., + 0.68 was found in the Eskimos and the most unfavourable correlation, viz., + 0.31, in the Chinese. The maximum and minimum correlations obtained for the same cranial lengths by the writer, namely, + 0.65 and + 0.35 very closely accord with these. It is rather interesting to note that Schultz found the most favourable correlation to exist in a homogeneous race like the Eskimo.

TABLE 1.

To Show That the Ranges of Variation of the Glabella-Occipital, Nasion-Basion and Nasion-Pituitary Lengths Tend to be Greatest in the White Races, and Also Consistent for the Two Sexes.

	Glabella-occipital length		Nasion-basion length		Nasion-pituitary length	
	Max.	Min.	Max.	Min.	Max.	Min.
Male White	210.0 mm.	160.5 mm.	110.5 mm.	87.0 mm.	73 mm.	50.5 mm.
Female White	193.0 mm.	161.5 mm.	105.0 mm.	85.5 mm.	66 mm.	50.5 mm.
Male Negro	206.5 mm.	168.0 mm.	109.5 mm.	91.0 mm.	68 mm.	51.5 mm.
Female Negro	192.5 mm.	169.0 mm.	107.0 mm.	87.0 mm.	66 mm.	52.0 mm.

The ranges of variation of the glabella-occipital and the nasion-basion lengths were fully discussed in Craniometric Study No. 1, (1)where it was found that the greatest degrees of instability were manifested by the White races, particularly the male White. The results yielded by the nasion-pituitary length corroborate these, for it was ascertained that its range of variation was from a maximum of 73 mm. to a minimum of 50.5 mm. in the male Whites, whereas in the male Negroes the corresponding figures were 68 mm. and 51.5 mm. The female Whites likewise exhibited a greater range than the female Negroes, the respective fluctuations being from 66 mm. to 50.5 mm. and from 66 mm. to 52 mm. (see Table 1). These results thus still further confirm Professor Todd's conclusion (4) that the White population of Cleveland, the main source of the Hamann Museum Collection, exhibits a markedly heterogeneous character.

It is interesting to note that these conclusions regarding the variations of the nasion-basion length are corroborated by Schultz's results. His material was represented by six more or less homogeneous racial groups, as proved by the small ranges of variation and the low standard deviations and coefficients of variation. The Eskimos from the very fact of their geographical isolation would be expected to be a very homogeneous race. This is confirmed by a study of Schultz's tables, for it will be noted that in his first table the range of variation of the nasion-basion

length in the Eskimo male was from 115 mm. to 101 mm. and in the female Eskimo from 109 mm. to 98 mm., both surprisingly slight, especially when compared with the amazing fluctuations of the Hamann Museum male White material. (See Table 1.)

The same striking contrast is obtained by a survey of the standard deviations and of the coefficients of variation in Table 3 of his memoir. These are very low in such homogeneous types as the Eskimo and the Aboriginal Australian.

TABLE 2.

To Show that the Standard Deviation and the Coefficient of Variation of the Nasion-Basion Length are Much Higher in the American White than in the Eskimo or the Aboriginal Australian (the Latter two are Taken from Schultz's Third Table).

	American White		Eskimo		Aboriginal Australian	
	S. D.	C. of V.	S. D.	C. of V.	S. D.	C. of V.
Male.........	4.39	4.39	1.62	2.88	1.56	2.87
Female.......	4.51	4.75	1.68	2.99	1.73	3.20

It may be noted from Table 3 below, that the mean nasion-pituitary length is greater in the White races, this result being, moreover, consistent for both sexes. This point will merely be referred to here as it is to form the subject of Craniometric Study No. 4.

TABLE 3.

The Nasion-Pituitary Length. The Standard Deviation and the Coefficient of Variation Tend to be Consistently Higher in the White Races. Note that the Mean Nasion-Pituitary Length is Greater in the White Races, this Result Being Consistent for Both Sexes.

	Mean	Standard deviation	Coefficient of variation
Female Whites.....	58.5±0.321	3.40±0.227	5.81±0.387
Male Whites.......	61.0±0.117	3.30±0.082	5.40±0.135
Female Negroes....	57.5±0.329	2.97±0.232	5.16±0.404
Male Negroes......	59.5±0.179	3.30±0.127	5.54±0.213

TABLE 4.

To Show That the Standard Deviation and the Coefficient of Variation of the Maximum Glabella-Occipital, Nasion-Basion and Nasion-Pituitary Lengths are Consistently Higher in the White Than in the Negro.

	Maximum glabella-occipital length		Nasion-basion length		Nasion-pituitary length	
Female Whites	7.54	4.32	4.51	4.75	3.40	5.81
Male Whites	7.98	4.39	4.39	4.39	3.30	5.40
Female Negroes	5.55	3.08	4.32	4.50	2.97	5.16
Male Negroes	5.99	3.22	4.27	4.25	3.30	5.54

It will likewise be observed from Table 3 that the standard deviation and the coefficient of variation of the nasion-pituitary length tend to be consistently higher in the White races, particularly in the case of the females. It is worthy of remark that this result confirms the conclusions already obtained for two other cranial lengths, namely the maximum glabella-occipital and the nasion-basion. In order to render this

point more emphatic the standard deviations and the coefficients of variation for all three cranial lengths have been grouped in Table 4.

The method of calculating the various correlations has already been fully described in Craniometric Study No. 1 (1). It may be noted first of all that a very definite correlation between the nasion-pituitary length and the maximum glabella-occipital length was found to exist in all four groups of crania. This was a very gratifying conclusion, in view of the fact that the main idea of this research was to choose a shorter basal cranial length, in order to ascertain if a result would be yielded, corresponding in any way to that obtained in the case of the longer nasion-basion length. As a matter of fact, in addition to the existence of a very definite correlation in both cases, there were likewise some remarkably close degrees of correspondence. These are represented in Table 5. First of all, it will be observed that in both cases the most favourable correlation was found to exist in the female White crania. In the second place the most unfavourable correlation in both cases was yielded by the female Negro crania. This unfavourable correlation may be due in part at least to the small number of crania examined—37. Yet the most favourable correlation was found in the female White crania of which only 51 were available for study.

The correlations yielded by the male White and male Negro crania were remarkably close, as a casual inspection of Table 5 shows very vividly, the differences only amounting to 0.03 and 0.04 in the two cranial lengths.

TABLE 5.

Correlation Between the Maximum Glabella-Occipital Length on the One Hand, and the Nasion-Basion and Nasion-Pituitary Lengths on the Other.

	Nasion-basion length		Nasion-pituitary length
Female White......	$+0.65 \pm 0.054$	Female White......	$+0.52 \pm 0.068$
Male Negro.......	$+0.47 \pm 0.042$	Male White.......	$+0.45 \pm 0.028$
Male White........	$+0.44 \pm 0.028$	Male Negro	$+0.41 \pm 0.045$
Female Negro......	$+0.35 \pm 0.096$	Female Negro......	$+0.39 \pm 0.094$

It will be noted that the most favourable correlation was found in the female White material, and the most unfavourable in the female Negroes. The male material occupied the intermediate position in both cases and yielded very close results in the two races. The wide divergence of the correlations in the females of the two races is noteworthy.

These results show the value of having abundance of cranial material to work upon. As the Hamann Museum Collection expands in volume it is the writer's intention, with Professor Todd's kind consent and approval, to continue this research in the female crania of both races until the numbers examined equal those of the male series. In this way even more balanced results will probably be obtained.

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THE LENGTHENING OF THE ANTERIOR PORTION OF THE CRANIAL BASE IN THE WHITE RACES

Craniometric Studies, No. 4

In the second craniometric study attention was directed to the fact that there was a shortening of the nasion-basion length in the American White skull as compared to that of the American Negro. The difference proved to be very slight, amounting to 0.5 mm. in the male series, and 1.1 mm. in the female series, but its very definite character, and the fact that it was consistent for the two sexes justified a full investigation into the condition.

This discovery stimulated the writer to make an investigation into the relative dimensions of the anterior portion of the cranial base in the White and Negro races. He chose the nasion-pituitary length to represent this portion of the cranial base in preference to the glabella-pituitary, owing to the extreme variations in the dimensions of the frontal sinuses which create corresponding fluctuations in this measurement. In comparison with it the nasion-pituitary length is more stable.

The writer was astonished to find that there was a definite increase in the mean nasion-pituitary length in the White races, as compared with the Negro. Moreover, this lengthening was found to be consistent for the two sexes. The increases were slight—1 mm. in the females, and 1.5 mm. in the males, but their definite and consistent character merited an exhaustive investigation. (See Table 1.)

TABLE 1.

To Show that, Though the Average Distance from the Nasion to the Basion is Less in the American White than in the American Negro, Yet the Anterior Basal Measurement Represented by the Nasion-Pituitary Length is Greater in the White Races. It Will be Noted that These Results are Consistent for Both Males and Females.

	Mean nasion-basion length	Mean nasion-pituitary length
Female White	94.8 mm.	58.5 mm.
Female Negro	95.9 mm.	57.5 mm.
Male White	100.0 mm.	61.0 mm.
Male Negro	100.5 mm.	59.5 mm.

The problem that has to be dealt with in this paper is thus somewhat anomalous. How are we to explain a lengthening of the nasion-pituitary length in the White races, in view of the fact that there is an actual shortening of the nasion-basion length?

The collection of crania in the Hamann Museum, Western Reserve University, was again made use of, and the writer wishes to thank Professor T. Wingate Todd for the free use of that material. 599 crania were utilized consisting of 358 male White, 153 male Negro, 51 female White and 37 female Negro.

The writer wishes to mention that the pituitary point was selected by himself for craniometric purposes. The reasons for and against that selection have been detailed in a previous communication (1).

A possible clue to this alleged lengthening of the anterior part of the cranial base is provided by an investigation into the evolution of the brain and particularly its frontal lobes. In this relationship it is convenient to mention at this stage a statement made on this subject by the writer (2) eight years ago.—"There are two great factors in operation during the evolution of the frontal region of the skull. The first is a gradual increase in the size of the bregmatic angle, while the second is superadded to this in the form of a concomitant bulging outwards and forwards of the frontal cranial arc, rather after the fashion of the way in which an archer bends his strongbow."

It is clear from what has been just stated that there is a progressive forcing upwards of the frontal arc of the cranial roof by the developing frontal lobes of the brain, the idea being to provide more accommodation for the evolutionary expansion of the cerebral hemispheres. This quadrant of the skull certainly provides us with a vivid mental picture of the reciprocal adaptation of the skull to its cerebral contents. As the writer (3) says in a previous paper—"it must always be borne in mind that the skull is simply an osseous box for the reception of the brain and its membranes, and as such is forced to adapt itself to the growth of its contents during embryonic life. Therefore the development of the brain absolutely determines not only the size but also the shape of the box, the design and architecture of the latter being entirely controlled by the expansion of its cerebral contents."

The main purpose of this paper, is to show that, in addition to a raising of the roof of the frontal cranial arc there is also a lengthening of the floor. This idea is demonstrated in Fig. 2, where it will be noticed that, acting from the pituitary point as an arbitrary fixed point, there is expansion in the directions indicated by the four arrows. In this figure the

outline of the outer surface of a European type of skull has been superimposed upon that of a Melanesian type, both having been previously brought to the same standard scale of measurement. This plan seemed to illustrate in a vivid manner this idea of the "raising of the cranial roof." It will be observed that the line directed vertically upwards from the pituitary point reached the vertex just in front of the bregma in both crania. The exact relation of this line to the bregma will have to be postponed until a sufficient number of mesially sectioned crania are available for study. It is essential, however, that attention be directed at this point to this important relationship.

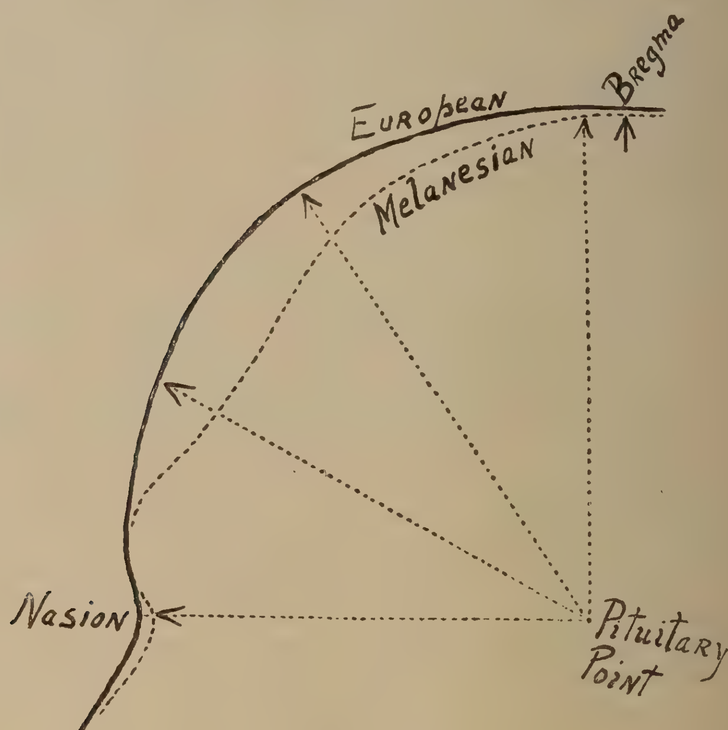

Fig. 2. In the evolution of the skull there is expansion in all the directions indicated by the arrows. Note that the "raising of the cranial roof" occurs almost entirely in front of the bregma.

The significant point brought out in this communication is, that the raising of the cranial roof which occurs in higher races takes place for the most part in front of the bregma. This was confirmed by a study of the auricular height of the Hamann Museum crania, as recorded by Win-

gate Todd (4). In Table XI on page 166 of his memoir it will be noted that the mean cranial height in the male Whites was 116.4 mm. and in the male Negroes 115.5 mm.—a difference of only 0.9 mm. In the case of the females the difference was found to be even less, the mean cranial height in the female Whites being 112.29 mm. and in the female Negroes 112.20 mm.—a difference in favour of the Whites of only 0.09 mm. It is therefore clear that we are forced to go in front of that vertical plane to find an expansion of the cranial roof to provide accommodation for the greater size of the brain in the white races. It does not take place posterior to that plane. Thus we revert to the very fundamental fact stated by the writer (2) in a previous communication—"the growth and expansion of the skull both tell us that the frontal lobes of the brain are amongst the last parts of that organ to complete their evolutionary history."

The writer thought it well to investigate the cranial heights of the White and Negro races as given in the Royal College of Surgeons Museum Catalogue. It may be noted that in this instance the basion-bregma measurement was utilized to represent the cranial height.

The male Anglo-Keltic skulls of this collection were contrasted with the male African Negro crania. In the British series, numbered 288 to 349 in the catalogue, it was found that 44 skulls were definitely adult male. The range of variability of the cranial height in this group was from a maximum of 145 mm. to a very low minimum of 119 mm. with an average of 133.2 mm.

Fifty male African Negro crania in the catalogue series 1219 to 1257 were contrasted with the Anglo-Keltic types. In the Negro group the range of variation of the cranial height was from a maximum of 146 mm. to a minimum of 123 mm., with a mean of 136.7 mm.

It will be noted in the first place that just as in the case of the Hamann Museum collection, the range of variation was generally greatest in the White crania. This was an outstanding feature of the writer's first three craniometric studies.

In the second place it will be observed that the mean cranial height of the African Negro skull is much greater than that of the Anglo-Keltic cranium, as opposed to a very slight superiority of the American White over the American Negro cranial height. This may be partly due to the difference in method employed in the two collections of crania, but the contrast is so outstanding that other explanations will have to be looked for.

In the meantime, one fact stands out clearly, namely, that the mean cranial height of the Negro skull may actually surpass that of the White cranium, so that the demand is all the greater for an increase in the dimensions of the frontal segment, not only in a vertical but also in a horizontal direction, in order to provide accommodation for the evolutionary activity of the frontal lobes of the brain. Therefore it is highly probable that the lengthening of the nasion-pituitary line in the White races is part of this scheme of evolutionary expansion.

Conclusions

1. There is a definite increase in the mean nasion-pituitary length in the White races as compared with the Negro.
2. This lengthening is consistent for the two sexes.
3. This lengthening is probably due to the evolutionary expansion of the frontal lobes of the brain.
4. The mean cranial height of the Negro skull may actually exceed that of the White, so that the demand is all the greater for an increase in the dimensions of the frontal segment, not only in a vertical but also in a horizontal direction, in order to provide accommodation for the evolutionary activity of the frontal lobes of the brain.
5. It is highly probable that the lengthening of the nasion-pituitary line in the White races is part of this scheme of evolutionary expansion.

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THE TEMPORO-FRONTAL ARTICULATION IN MAN

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In a previous paper[1] the results of the writer's study of the formation of the pterion in apes were given. The relation of the bones in the region of the pterion was found to be very variable, most genera of the old world apes showing the temporo-frontal as well as spheno-parietal articulation, while in the American monkeys the articulation was found to be spheno-parietal and spheno-malar-parietal.

An examination of the human crania in the U. S. National Museum was next made in order to determine the percentage of occurrence of the temporo-frontal, or exceptional, articulation. I am indebted to Dr. Hrdlička for the task of examining this material as well as for numerous helpful suggestions throughout the work.

Included in the present study are all pterions in which the articulation was other than the usual H form, or spheno-parietal. All pterions in which the temporal and frontal came into contact, whether by a wide or narrow articulation, are included in the first part of the tables. Epipteric bones were noted only when their presence made it impossible to determine the articulation; that is, when the epipteric occupied the entire space of the pterion, connecting with the frontal, parietal, temporal, and sphenoid. Of the skulls examined 8,472 had the pterion visible on one or both sides, the total number of pterions being 15,803.

The results of the present study confirm in general those that have been made before, in which the temporo-frontal connection and epipteric bones were found most frequently in the Melanesians, Australians, and Negroes.

The most extensive former investigations on the temporo-frontal articulation were those of Anoutchine and Ranke, whose results, together with mine for the same groups, are given on page 346.

The number of skulls examined by Ranke was 4,861, which number combined with Anoutchine's 15,169, makes the total of 20,030.

Among 9,501 European skulls examined by himself and others, Le Double records the presence of the temporo-frontal articulation on 166, or 1.7 percent.

In order that my data might be more easily compared with those of the previous writers I have followed their method in the above summary. That is, an equal value has been given to all skulls in which the temporo-frontal articulation was found, whether on one side or on both

[1]Am. J. Phys. Anthrop., 1925, VIII, No. 4.

AM. J. PHYS. ANTHROP., 1926, Vol. IX, No. 3.

	Number of pterions	Temporo-Frontal Articulation: Both sides No.	Both sides Per cent	One side (Normal pterion on other) No.	Per cent	One side (Epipteric bone on other) No.	Per cent	One side (Pterion on other side?) No.	Per cent	Total temporo-frontal articulations No.	Per cent	Epipteric Bones: Both sides No.	Both sides Per cent	One side (Normal pterion on other) No.	Per cent	One side (Temporo-frontal art. on other) No.	Per cent	One side (Pterion on other side?) No.	Per cent	Total pterions with epipteric bones No.	Per cent
Male																					
WHITES:																					
American	192	1	.5	—	—	—	—	—	—	2	1.0	—	—	6	3.1	—	—	—	—	6	3.1
European	168	—	—	1	.6	—	—	—	—	1	.6	2	1.2	3	1.8	—	—	—	—	7	4.1
Egyptian	316	1	.3	2	.6	2	.6	—	—	6	1.9	7	2.2	7	2.2	2	.6	2	.6	25	7.9
YELLOW-BROWNS:																					
Asiatic (East and North)	316	—	—	1	.3	2	.6	—	—	3	.9	5	1.6	7	2.2	2	.6	—	—	19	6.0
Malay	59	1	1.7	—	—	—	—	—	—	2	3.4	1	1.7	5	8.5	—	—	—	—	7	11.9
Eskimo	424	—	—	3	.7	—	—	—	—	3	.7	2	.5	7	1.7	—	—	—	—	11	2.6
American Indian	5879	14	.2	26	.4	3	.05	4	.07	61	1.0	28	.5	92	1.6	3	.05	2	.03	153	2.6
POLYNESIANS:	146	4	2.7	—	—	—	—	—	—	8	5.5	1	.7	4	2.7	—	—	—	—	6	4.1
AUSTRALIANS & TASMANIANS	44	—	—	—	—	—	—	6	13.6	6	13.6	—	—	—	—	—	—	5	11.4	5	11.4
MELANESIANS:	55	4	7.3	2	3.6	1	1.8	1	1.8	12	21.7	3	5.5	1	1.8	1	1.8	—	—	8	14.5
NEGROES:	149	4	2.7	—	—	—	—	1	.7	9	6.0	1	.7	1	.7	—	—	—	—	3	2.0
NEGRITO:	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Female																					
WHITES:																					
American	73	1	1.4	—	—	—	—	—	—	2	2.7	—	—	1	1.4	—	—	—	—	1	1.4
European	68	—	—	—	—	—	—	—	—	—	—	—	—	4	5.9	—	—	—	—	4	5.9
Egyptian	228	1	.4	1	.4	1	.4	—	—	4	1.8	5	2.2	10	4.4	1	.4	4	1.8	25	11.0
YELLOW-BROWNS:																					
Asiatic (East and North)	201	—	—	3	1.5	—	—	—	—	3	1.5	6	3.0	5	2.5	—	—	1	.5	18	9.0
Malay	46	1	2.2	—	—	—	—	—	—	2	4.3	—	—	1	2.2	—	—	—	—	1	2.2
Eskimo	288	1	.3	7	2.4	—	—	—	—	9	3.1	4	1.4	12	4.2	—	—	—	—	20	6.9
American Indian	5947	20	.3	26	.4	3	.05	2	.03	71	1.2	39	.7	85	1.4	3	.05	10	.2	176	3.0
POLYNESIANS:	163	—	—	—	—	—	—	—	—	—	—	5	3.1	1	.6	—	—	—	—	11	6.7
AUSTRALIANS & TASMANIANS	24	—	—	—	—	—	—	5	20.8	5	20.8	1	4.2	—	—	—	—	1	4.2	3	12.5
MELANESIANS:	48	1	2.1	3	6.2	—	—	1	2.1	6	12.5	2	4.2	1	2.1	—	—	—	—	5	10.4
NEGROES:	99	2	2.0	2	2.0	—	—	—	—	6	6.1	1	1.0	3	3.0	—	—	—	—	5	5.1
NEGRITOS:	2	—	—	—	—	—	—	—	—	—	—	—	—	1	50.0	—	—	—	—	1	50.0
Children																					
WHITES:																					
Egyptian	56	—	—	—	—	—	—	—	—	—	—	2	3.6	1	1.8	—	—	1	1.8	6	10.7
YELLOW-BROWNS:																					
Eskimo	22	—	—	1	4.5	—	—	—	—	1	4.5	—	—	1	4.5	—	—	—	—	1	4.5
American Indian	660	2	.3	3	.5	1	.2	—	—	8	1.2	2	.3	6	.9	1	.2	1	.2	12	1.8
POLYNESIANS:	36	—	—	1	2.8	—	—	—	—	1	2.8	1	2.8	1	2.8	—	—	—	—	3	8.3

MALE, FEMALE, AND CHILDREN

	Number of pterions	Pterions with temporo-frontal articulations		Pterions with epipteric bones	
		Number	Per cent	Number	Per cent
WHITES:					
American	265	4	*1.5*	7	*2.6*
European	236	1	*0.4*	11	*4.7*
Egyptian (Mostly 12th Dynasty)	600	10	*1.7*	56	*9.3*
YELLOW-BROWNS:					
Siberians	78	1	*1.3*	8	*10.2*
Mongolians, Urga	371	4	*1.1*	19	*5.1*
Japanese	42	1	*2.4*	9	*21.4*
Chinese	26	—	—	1	*3.8*
Total Asiatic (East and North)	(517)	(6)	(*1.2*)	(37)	(*7.2*)
Malay	105	4	*3.8*	8	*7.6*
Eskimo	734	13	*1.8*	32	*4.4*
American Indians:					
Aleutians	106	—	—	5	*4.7*
Northwest Coast and Alaska	244	2	*0.8*	11	*4.5*
California	746	2	*0.3*	15	*2.0*
Utes and Piutes	89	—	—	8	*8.9*
Western Algonkians	164	—	—	3	*1.8*
Sioux	339	—	—	6	*1.8*
Dakota Mounds	239	5	*2.1*	7	*2.9*
Plains, Misc.	241	—	—	4	*1.7*
Mounds, Middle West	367	8	*2.2*	6	*1.6*
Northeastern U. S. and Canada	244	—	—	8	*3.3*
Kentucky Mounds (Ohio County)	102	—	—	7	*6.8*
Southern Mounds	834	8	*1.0*	41	*4.9*
Pueblo	1252	1	*0.1*	23	*1.8*
Navaho	38	—	—	—	—
Apache	39	—	—	1	*2.6*
N. American Indians, Misc.	89	1	*1.1*	4	*4.5*
Mexico	84	2	*2.4*	2	*2.4*
Jamaica & Santo Domingo	18	—	—	9	*50.0*
Peru, Pachacamac	3946	65	*1.6*	115	*2.9*
Peru, Chicama	1614	17	*1.1*	38	*2.4*
Peru, Misc.	1550	25	*1.6*	26	*1.7*
Bolivia	20	4	*20.0*	3	*15.0*
Patagonia	65	—	—	1	*1.5*
S. American Indians, Misc.	56	—	—	—	—
Total American Indians	(12486)	(140)	(*1.1*)	(341)	(*2.7*)
POLYNESIANS:					
Hawaiian	291	9	*3.1*	19	*6.5*
New Zealand	54	—	—	1	*1.9*
Total Polynesians	(345)	(9)	(*2.6*)	(20)	(*5.8*)
AUSTRALIANS:[1]	116	11	*9.4*	6	*5.6*
TASMANIANS:	42	11	*26.2*	6	*14.3*
Total	(158)	(22)	(*13.9*)	(12)	(*7.6*)
MELANESIANS:					
New Britain	45	13	*28.9*	4	*8.9*
Fiji and Solomon Ids	22	1	*4.5*	4	*18.2*
New Guinea	28	2	*7.1*	4	*14.4*
Misc. Melanesians	8	2	*25.0*	1	*14.8*
Total Melanesians	(103)	(18)	(*17.5*)	(13)	(*12.6*)
NEGROES:	248	13	*5.2*	8	*3.2*
NEGRITOS:	6	—	—	1	*16.7*

[1]The 42 Tasmanian pterions and 90 of the Australian were obtained from Vols. 5 and 6 of the Trans. of the Royal Soc. of Victoria, in which are shown dioptrographic tracings of the crania. The sex of the Australian crania was not given.

	Ranke			Anoutchine			Collins	
	Number of skulls	Skulls with temporo-frontal articulation	Per-cent	Number of skulls	Per-cent	Number of skulls	Skulls wth temporo-frontal articulation	Per-cent
European	11,000	169	*1.5*	9,867	*1.6*	250	3	*1.2*
American	2,520	43	*1.7*	2,335	*1.6*	6,243	104	*1.7*
Asiatic	1,200	24	*2.0*	1,194	*1.9*	73	2	*2.7*
Mongolian	710	27	*3.8*	596	*3.7*	185	4	*2.1*
Malayian and Polynesian	1,250	54	*4.3*	946	*3.7*	225	7	*3.1*
North African	830	47	*5.7*	—	—	300	9	*3.0*
Papuan	787	73	*9.3*	697	*8.6*	14	2	*14.3*
Australian	422	38	*9.0*	210	*15.7*	103	11	*10.7*
Veddas, Tamils and Singalese	81	9	*11.1*	—	—	—	—	—
Negroes	1,231	146	*11.9*	884	*12.4*	124	7	*5.6*
Total	20,030	637	*3.1*	15,169	*3.0*	7,517	149	*2.0*

sides. In the tables giving my complete observations, however, a different method is followed. The data are there reduced to pterions, whereby skulls with this articulation or with epipteric bones on one side are given but half the value of those in which such features are found on both sides. The resulting percentages are lower but they reveal more exactly the conditions as found. Sullivan has recorded the formation of the pterion on 2081 American Indian and Eskimo crania and has also observed this distinction. His results, somewhat condensed, are as follows:

Group	Number examined	Percent	Group	Number examined	Percent
California	20	7.5	Basket makers and Utah	115	0.9
Bolivia	718	5.1	Southern Mounds	66	0.8
Peru	139	1.8	Pueblo	92	0.5
Mexico	311	1.6	Middle West Mounds	23	0.0
Northwest Coast	404	1.2			
Eskimo	193	1.0			

Sullivan's group of 2081 skulls shows a higher frequency of the temporo-frontal articulation, 2.6%, than the American Indian and Eskimo crania examined by the writer, 6610, in which the articulation was present in 1.2%. However, about half of Sullivan's crania are Bolivian and Mexican and these are the two groups which, according to my figures, show the greatest frequency of the temporo-frontal articulation among American Indians. Furthermore, Sullivan's list includes comparatively few skulls from groups which I found to be of low frequency, such as the Pueblo, California, Plains, Southern Mounds and others, all of which are represented by considerable numbers in my series. The two series thus supplement each other and the combined average of 1.5% may very likely be safely regarded as a true indication of the degree of occurrence of the temporo-frontal articulation in the American Indian and Eskimo.

As to sex, the temporo-frontal articulation and epipteric bones in the present series were found to be distributed as follows:

Males

Total number of pterions	7752	
Pterions with temporo-frontal articulations	113	(1.45%)
Pterions with epipteric bones	250	(3.22%)

Females

Total number of pterions	7187	
Pterions with temporo-frontal articulations	108	(1.50%)
Pterions with epipteric bones	270	(3.75%)

Children

Total number of pterions	774	
Pterions with temporo-frontal articulations	10	(1.29%)
Pterions with epipteric bones	22	(2.84%)

The proportion of epipteric bones to temporo-frontal articulations is thus seen to be more than two to one, and both features are of somewhat greater frequency among females than males. As stated above, the epipteric bones here recorded are only those which connect with all four of the bones, frontal, parietal, temporal, and sphenoid. Epipterics which did not affect the normal spheno-parietal articulation were not included.

The contact of the temporal and frontal bones is produced most frequently by an upward projection from the temporal, the "frontal process of the temporal bone," and less frequently by a temporal process of the frontal bone. The cause of this variation remains to be determined. It has been attributed to an arrested development of the wing of the sphenoid, to the soldering of an intertemporal bone to the temporal squama, and to the annexation of an epipteric bone. This last theory may possess a certain plausibility due principally to the appearance of the articulation, which in the majority of cases is made by a relatively narrow and sudden projection, usually from the temporal and less frequently from the frontal, such as might naturally have resulted if an epipteric had become attached to one of these two bones. The appearance of the temporo-frontal connection in man is quite different from that in the apes, where the epipteric bone is very rarely found, for there the articulation is as broad and regular as the spheno-parietal, even in a species where the two types may be about equally distributed. In short, the annexation of an epipteric bone, if it could be shown to have taken place, would very readily explain the occurrence of the temporo-frontal articulation in man in the great majority of cases. But until this can be done, or until some other reason can be satisfactorily shown, the cause of this irregularity must remain in doubt. A point against this theory, in Dr. Hrdlička's opinion, is that no case is known in which a partial suture would separate the process, indicating its former separateness.

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THE LOCATION OF NASION IN THE LIVING

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In taking anthropometric measurements on the face and nose, a difficulty frequently met with is to exactly locate the nasion. The best way when possible is, of course, actually to feel the naso-frontal suture. But this is difficult in practice and often impossible. Even the directions for the location of the nasion are sometimes misleading, as when it is stated that the nasion is the most depressed point at the root of the nose. Recourse must therefore be had to knowledge based upon study of the skulls and more or less close approximations. Granted this is the best we can do, a desideratum still remaining is to determine the variability of the point and to ascertain what racial and sex differences exist in its location relative to the neighboring structures.

At Dr. Hrdlička's suggestion, the writer made a study of the crania in the collection of the U. S. National Museum for the purpose of obtaining this information, and the results are reported in this paper. The writer takes this opportunity of cordially thanking Dr. Hrdlička for facilities and instruction in methods.

The position of the nasion was taken in relation to two other points on the skull which are easily determined. These are the glabella and the point of intersection of a line connecting the highest normal points of the upper orbital borders and the median sagittal plane, (point called by Martin, "Lehrb.," p. 506, somewhat inappropriately, the "supraorbitale.")[1] The utilized material comprises as many races as were found better represented in the collections. Some of the series may not have been fully sufficient. The measurements were made with accurate anthropometric calipers (compas glissière), and with all possible care as to accuracy. As further remarks seem unnecessary we may proceed at once to the results.

Table 1 shows the distances in millimeters from glabella to nasion in a series of skulls of males and females of different races, and the percentage for each distance. The mean distance (M) with its error is given for each race and sex, as well as the standard deviation (S. D.) in the larger series.

From the following table it is apparent that the average distance from glabella to nasion is slightly greater in the female than in the male in all

[1]Dr. Hrdlička advises calling this point simply "the upper mid-orbital point" which term will be used in this paper.

TABLE 1.—MALE.

Race	N.	Distance from glabella to nasion 7 mm. Per-cent	8 mm. Per-cent	9 mm. Per-cent	10 mm. Per-cent	11 mm. Per-cent	12 mm. Per-cent	13 mm. Per-cent	14 mm. Per-cent	15 mm. Per-cent	16 mm. Per-cent	Mean mm.	S. D.
Whites	50	2.0	8.0	18.0	28.0	22.0	12.0	6.0	4.0			10.4 ± 0.14	1.0
Australians	10		20.0	30.0	20.0	30.0						9.6	
Polynesians	16			6.2	43.8	12.5	12.5	25.0				11.1	
Mongolians (Urga)	50		4.0	4.0	28.0	26.0	16.0	16.0	4.0	2.0		11.2 ± 0.2	1.4
Chinese and Japanese	20			10.0	25.0	20.0	30.0	5.0		10.0		11.4	
Malay	23		4.3	13.0	26.0	34.8	21.7					11.5	
Eskimo	100				10.0	21.0	29.0	19.0	13.0	8.0		12.2 ± 0.14	1.4
Indians, N. & S. America	100			1.0	12.0	27.0	33.0	13.0	12.0	2.0		11.9 ± 0.16	1.6
Melanesians	22		4.5	22.7	31.8	27.2	13.6					10.2	
Negroes, America and Africa	62	1.6	12.9	27.4	29.0	11.2	12.9	4.8				9.9 ± 0.18	1.8
FEMALE													
Whites	50			10.0	14.0	24.0	30.0	10.0	6.0	4.0	2.0	11.6 ± 0.21	1.5
Polynesians	18				11.1	22.2	22.2	27.7	11.1		5.5	12.2	
Mongolians (Urga)	50			10.0	14.0	12.0	36.0	16.0	12.0			11.8 ± 0.2	1.4
Chinese and Japanese	10				10.0	30.0	20.0	20.0	20.0			12.1	
Malay	22				9.1	22.7	27.3	22.7	9.1	9.1		12.2	
Eskimo	100			1.0	16.0	21.0	24.0	17.0	9.0	7.0	5.0	12.2 ± 0.14	1.4
Indians, N. & S. America	100				5.0	17.0	24.0	18.0	23.0	8.0	5.0	12.8 ± 0.15	1.4
Melanesians	10				20.0	50.0	20.0	10.0				11.2	
Negroes, America and Africa	28		10.7		14.3	32.1	28.6	7.1	7.1			11.1 ± 0.17	1.5

races except the Eskimo, though here also the range extended to greater distances in females than in males. The mean of the female skull is about a millimeter greater than the mean of the male.

The group of Whites is made up of American and European skulls. The minimum distance for the male Whites was as low as in Negroes (7 mm.), but in female Whites the maximum was greater than in Negroes.

Unfortunately only ten male skulls of Australians were available for observation. The distance between glabella and nasion is less on the Australian skulls than in other races, though not appreciably different from that of Negroes.

In Polynesians, Mongolians, Chinese and Japanese and Malay, the mean distance is about a millimeter greater than in Whites and Australians.

The Eskimo series is largely made up of skulls from St. Lawrence Island, Alaska and Greenland but include also some Asiatic Eskimo. In the Eskimo female, the nasion would very probably be difficult to determine as it is not deeply inset as in males and lies higher than the nasal depression.

The Indian group is made up of fifty skulls of each sex from Arkansas, and fifty of each sex from Peru. When taken separately, the mean distances are practically the same in Peruvian and Arkansas skulls, male and female. As in the Eskimo, the nasion in the female is not deeply inset as in the male and would be more difficult to locate. This is generally true of female skulls in other racial groups studied.

The group of Melanesians is made up of skulls from New Hebrides, New Britain and New Caledonia. The mean distance is slightly greater than in Negroes.

The Negro group includes both African and American full-blood Negroes. The mean distance approaches that found in Australians.

There thus appears to be a slight racial difference as well as a sex difference. As the groups are unequal and some quite small, one is hardly warranted in making a positive generalization, but according to results tabulated, an appreciable difference exists between the Eskimo and Indians on the one hand, and the Negroes and Australians on the other.

Table 2 shows the distances in millimeters from the upper mid-orbital point to nasion on the same skulls as the glabella-nasion measurement was made. In locating the upper mid-orbital point, a celluloid rule was placed transversely connecting the highest points in each orbit and marking the point where this horizontal cuts the median plane.

TABLE 2.—MALE.

Race	N.	5 mm. Per-cent	6 mm. Per-cent	7 mm. Per-cent	8 mm. Per-cent	9 mm. Per-cent	10 mm. Per-cent	11 mm. Per-cent	12 mm. Per-cent	13 mm. Per-cent	14 mm. Per-cent	Mean mm.	S. D.
		Distance from upper mid-orbital point to nasion											
Whites	50	2.0	8.0	24.0	22.0	22.0	18.0	4.0				8.2±0.18	1.3
Australians	10			20.0	40.0	30.0	10.0					8.3	
Polynesians	16			12.5	31.2	18.8	18.8	12.5	6.2			9.0	
Mongolians (Urga)	50	8.0	32.0	20.0	22.0	10.0	4.0	2.0	2.0			8.2±0.24	1.7
Chinese and Japanese	20			25.0	30.0	20.0	20.0			5.0		9.0	
Malay	23		4.3	4.3	43.5	17.4	21.7	8.7				8.7	
Eskimo	100		2.0	2.0	8.0	22.0	29.0	21.0	11.0	5.0		10.1±0.14	1.4
Indians, N. & S. America	100			7.0	19.0	21.0	30.0	15.0	6.0	2.0		9.5±0.11	1.1
Melanesians	22	4.5	9.1	31.9	22.7	22.7	9.1					7.7	
Negroes, America & Africa	62	4.8	8.1	12.9	22.5	29.0	9.7	11.3	1.6			8.3±0.16	1.3
FEMALE													
Whites	50		10.0	18.0	32.0	20.0	10.0	6.0	2.0			8.4±0.21	1.5
Polynesians	18			16.7	22.2	22.2	11.1	11.1	5.6	11.1		9.4	
Mongolians (Urga)	50		2.0	12.0	20.0	26.0	32.0	8.0				9.0±0.15	1.2
Chinese and Japanese	10			10.0	30.0	30.0	20.0	10.0				9.0	
Malay	22		4.5	9.1	18.1	22.7	22.7	22.7				9.2	
Eskimo	100			2.0	8.0	15.0	32.0	21.0	14.0	6.0	2.0	10.4±0.11	1.1
Indians, N. & S. America	100			2.0	10.0	24.0	27.0	22.0	10.0	5.0		9.9±0.13	1.3
Melanesians	10		10.0	10.0	10.0	30.0	30.0	10.0				8.9	
Negroes, America & Africa	28	3.6	3.6	14.3	21.4	25.0	10.7	17.8		3.6		8.8±0.3	1.6

There is generally a correlation in all races between the position of the glabella and the upper mid-orbital point, the latter being usually from two to three millimeters below the glabella. There is, however, a tendency in some skulls for these points to approach one another or even coincide.

SUMMARY

Taking the mean distances in the above tables to the nearest millimeter, we may summarize as in Table 3.

TABLE 3.

Race	From Glabella to Nasion Male mm.	From Glabella to Nasion Female mm.	From Upper Mid-orbital Point to Nasion Male mm.	From Upper Mid-orbital Point to Nasion Female mm.
Whites	10	12	8	8
Australians	10		8	
Polynesians	11	12	9	9
Mongolians	11	12	8	9
Chinese and Japanese	11	12	9	9
Malay	11	12	9	9
Eskimo	12	12	10	10
Indians	12	13	10	10
Melanesians	10	11	8	9
Negroes	10	11	8	9

CONCLUSIONS

1. From this study it is apparent that the mean distance from glabella to nasion is slightly greater in females than in males. This difference is greater than three times its standard error and is therefore significant. The upper mid-orbital point generally lies from two to three millimeters below the glabella.

2. On account of the small number of samples in several of the groups, it is not certain whether the racial differences are significant. The results, however point to such a difference; the distance between glabella and nasion is greater in Eskimos and Indians than in Australians and Negroids. The heterogeneous group of Whites likewise differs significantly from Eskimos and Indians.

3. In practical anthropometry on living subjects, the data given may help to arrive at a closer approximation in the location of the nasion where this point cannot be felt. The measurement from glabella would probably be more convenient than from the upper mid-orbital point, but in difficult cases the latter might prove a useful check.

THE CARTILAGE OF THE FEMUR IN THE WHITE AND THE NEGRO

Studies on the Femur, No. 2

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Among our accumulated data regarding the femur there is a considerable amount of material dealing with the fresh bone, before maceration and also before the removal of any articular cartilage. Advantage has been taken of the opportunity to determine the effects of cartilage upon a number of the more common, standard femoral measurements.

Throughout this paper all references are to *fresh, unmacerated* material, from which, however, the cartilage may or may not have been removed. The effects of maceration and drying upon these same bones and upon the same femoral measurements will be taken up in a future paper.

During the course of the work it was obviously necessary to keep the bones and cartilage moist in order to prevent any drying and consequent shrinkage.

The technique employed was, unless otherwise noted, the same as that used in our previous article on the femur, published in this journal. (Ingalls 1924). The material is naturally from the same source, but not as extensive. It comprises 36 pairs of femora from male whites; 10 pairs from male colored and 7 pairs from female colored, a total of 106 femora. The ages of the white material run from 33 to 80 years, but as far as our data goes, age has no appreciable effect upon the thickness or disposition of cartilage, neither does there appear to be any definite relation between the size of the bone and the thickness of the cartilage. As will appear later we have not been especially concerned with the absolute thickness of the cartilage at any particular point but rather with the role, if any, played by articular cartilage in modifying the form or proportions of the bone. It of course has not been possible to take into consideration the normal pressure upon the cartilage, or make any allowances for the consequent deformation.

1. OBLIQUE LENGTH

In this and the following tabulations all dimensions are in millimeters. Measurements have reference to the fresh bone, all cartilage being intact. Percentages are computed upon the same basis.

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The changes in the oblique length of the femur, due to the removal of all cartilage, are shown in the table below. In spite of the fact that the left bones show a somewhat greater mean length, the loss in length is slightly greater on the right except in the female colored. There also appears a somewhat smaller percentage loss in the colored, in both sexes, and here also the range of loss is rather less. Some of these discrepancies may very well be due to the smaller amount of colored material. Individual cases vary considerably in the effects of the removal of cartilage upon this particular measurement. The minimum of 1.5 mm. represents a reduction in length of .32%, the maximum of 5.5 is a reduction of

TABLE 1.
Oblique Length

		Mean	Mean loss	Percentage loss	Range of loss Min.	Max.
Male, white	Right	457.67	3.69	0.81	2.5	5.0
36 cases	Left	458.03	3.66	0.80	1.5	5.0
Male, colored	Right	468.8	3.8	0.81	1.75	5.5
10 cases	Left	472.8	3.32	0.70	2.5	4.5
Female, colored	Right	440.71	3.18	0.72	1.75	4.25
7 cases	Left	441.57	3.5	0.79	3.0	4.0

1.09%. Considering all of our material and both right and left sides, 106 femora, 3.61 mm. or .79% of a original oblique femoral length of 458.08 mm. is lost when the cartilage is removed. All of our percentages and the various indices which will be mentioned later are in terms of the fresh, moist bone with all cartilage intact, as near as it is possible to come to the living condition, but without reference to the normal, although varying pressure upon the cartilage.

The articular cartilage which is concerned in the oblique length is found in two locations; over the highest point of the head and covering the condyles on the infracondylar plane. Here, as in a number of other common femoral measurements, the dimensions in the recent state are altered by the presence of two layers of cartilage.

In order to throw some light on the relative importance of these two layers, we have taken the oblique length of the bone *after* removal of the cartilage from the infracondylar plane but *before* its removal from the head. The mean loss in oblique length, following removal of the cartilage from the condyles alone, is, in male whites, 1.70 mm. on the right side and 1.76 mm. on the left. In the male colored the corresponding figures are 1.78 and 1.75; in the female colored, 1.43 and 1.89. On account of the small series of colored material, one hesitates in calling attention to the agreement between these figures and those in the preceding table as indicating the greater influence of cartilage on the right in the male colored and on the left in the female. Although in male

whites the influence of the infracondylar cartilage is the reverse of that shown in the table for all the cartilage, the figures in the table for right and left are, for all practical purposes identical, the difference of .03 being covered by a probable error of $\pm$ .07.

The effects of the infracondylar cartilage are greater on the left side except in the male colored, the mean loss in length for all material being 1.55 on the right side and 1.65 on the left, but much of this difference is referable to the female material. The mean loss for both sides is 1.60 mm. as compared with 3.61 mm. when the cartilage of the head is also removed. As far as right and left are concerned the above results are reversed when all cartilage concerned has been removed, and again it is the colored material, in this case the female, which provides the exception. The mean loss after the removal of all cartilage is 3.63 mm. on the right side and 3.58 on the left.

2. OBLIQUE TROCHANTERIC LENGTH

TABLE 2.
OBLIQUE TROCHANTERIC LENGTH

		Mean	Mean loss	Percentage loss	Range of loss Min.	Max.
Male, white	Right	436.58	1.49	0.34	0.75	2.5
36 cases	Left	437.25	1.33	0.30	0.0	2.5
Male, colored	Right	443.6	1.86	0.42	0.75	3.0
10 cases	Left	447.7	1.64	0.37	0.75	2.5
Female, colored	Right	420.0	1.5	0.36	0.5	2.75
7 cases	Left	422.14	1.89	0.45	1.0	3.0

Only one layer of cartilage, that on the infracondylar plane, is responsible for the alterations in this dimension. In general the changes here are roughly parallel with those shown by the oblique length when only this cartilage has been removed. The mean losses for the two sides are 1.56 mm. on the right and 1.46 on the left. There are greater differences between right and left in the colored material, where the loss in the oblique trochanteric length equals the loss in the oblique length—with cartilage of head in place,—in the female on the left side, and exceeds it for both male and female colored on the right. The mean percentage loss for all material and both sides is .35%. For both of the measurements, involving only the infracondylar cartilage, the extreme, mean losses for all material are found in the female colored, greatest on the left and smallest on the right.

3. MAXIMUM TROCHANTERIC LENGTH

Like the preceeding, the alterations in this measurement are due to the removal of a single layer of cartilage. However, it is in this case the cartilage of the medial condyle alone and here along its inner border,

where it is thinner than over the convexity of the condyle. For the whole series there is little difference between the two sides. The right has suffered a mean reduction of 1.44 mm. the left 1.49 mm. Excepting again the female colored, the mean loss in length is greater on the left, with the colored material showing the greater discrepancies between the two sides.

The mean figures, right and left are, male white 1.47 and 1.51, male colored, 1.30 and 1.67, female colored, 1.43 and 1.18.

It will be noted that thus far we have made no intimation as to the thickness of the cartilage at any particular point. As stated in the beginning our interest has not been in the absolute thickness of the various femoral cartilages, but rather in their effects upon various standard measurements and upon certain other features which will appear later. What has been done is to apply a few of the more important measurements to what is practically living material. Another, and very good reason for failure to deduce any values for the thickness of the articular cartilages, is that there is another important factor at work in determining the results as given above.

We have spoken only of the reduction in length of the bone due to the removal of cartilage, and this is all that has been determined directly, at least in the measurements just considered. Only in case of the maximum trochanteric length is the thickness of cartilage the principle factor. It is evident, however, that the presence or absence of cartilage on the condyles might affect both the angle of obliquity and the angle of torsion, the one taken from an infracondylar the other from a retrocondylar plane. Alteration in the angle of obliquity may result in considerable changes in the oblique and oblique trochanteric lengths, differences due to a change in the torsion angle would be comparatively slight. What our figures show then, is a diminution in length resulting from the removal of cartilage from one or two locations and, superimposed upon this, the changes due to alteration in the obliquity of the bone.

Changes in the angle of obliquity, or in the torsion angle, would not occur if the cartilage removed were of uniform thickness. If the condylar cartilage in the infracondylar and retrocondylar planes is of unequal thickness on the medial and lateral condyles the effect of its removal will be some change in the angle of obliquity and in the torsion angle, and these effects may be much more marked than the effect upon the oblique lengths.

In order to preserve the cartilage in its normal condition and prevent any drying and consequent shrinkage, it did not seem possible to apply our former, more accurate methods for the measurement of the two

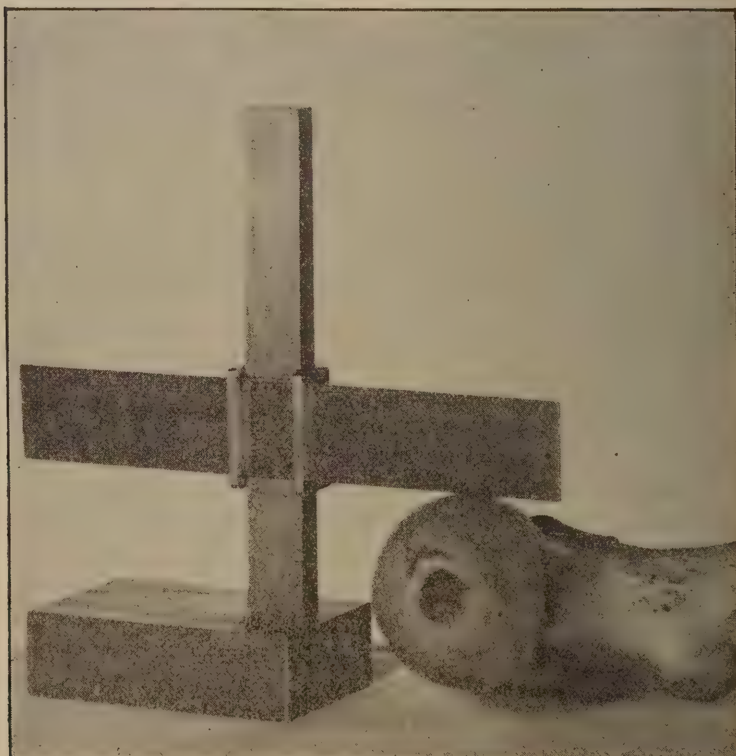
angles in question. We have consequently, contented ourselves with the determination of an increase or decrease in these angles, by a simple procedure, which, although very sensitive gives no direct angular values. With the bone in the oblique position and the infracondylar plane in contact with one of the vertical sides of the osteometric board and the median epicondyle in contact with the other vertical, we have determined the distance from the second vertical, i.e. from the tangent to the median epicondyle, to three points on the proximal end of the bone. These points were, the top of the great trochanter, the highest point of the head and the most medial point on the head. Comparison of these distances before and after removal of the infracondylar cartilage will reveal any alteration in the angle of obliquity due to varying thickness of the cartilage on the two condyles.

Possible effects of the removal of the retrocondylar cartilage on the angle of torsion have been determined by measuring the height of the highest point of the head in this case on its ventral surface—above the surface upon which the bone is lying. This measurement, together with a few others, was taken with the altimeter made in the department shop and shown in the accompanying illustration.

As regards the effect of changes in the angle of obliquity upon the oblique and oblique trochanteric lengths it is not possible to give any very definite figures. On account of the peculiar shape of the bone there are a number of factors at work in determining the effect of the angle of obliquity upon length as measured. By far the most important are the length of the individual bone and its angle of obliquity. Variations in the angle in a long bone will naturally give a greater absolute change in length, while if the initial angle of obliquity is very small, changes in it will have less effect upon the length than if the angle is large: i. e. the bone more oblique. Additional complicating factors are the length of the neck, the collar angle and to a less extent the torsion angle. If the head and great trochanter lie on opposite sides of the center about which the angle of the shaft is changing, then the oblique length may decrease while the oblique trochanteric increases, or vice versa. It is possible that some of the discrepancies in the behavior of the colored material, especially the female, may be due to certain anatomical peculiarities of the bones but we cannot be sure of this at present.

Since the changes in the obliquity of the shaft are much simpler than the changes in length we may proceed to a consideration of the former, with the reminder that the angle of obliquity has not been measured directly in degrees, but that increases or decreases have been noted in the manner outlined above.

The most outstanding feature is the tendency, especially in male whites, for the obliquity of the shaft to decrease after removal of the infracondylar cartilage. While the mean decrease is not great it is definitely more conspicuous on the left side. The head and great trochanter on the right move inward about 1.75 mm. toward the tangent to the



The altimeter shown above consists of a solid metal base supporting an upright 150 mm. in length. It is graduated in mm. and carries at right angles a second millimeter scale of the same length, which can be moved vertically or horizontally. On the end of the base, below the upright, are two tapered grooves which cut into the base at its lower edge leaving a narrow ridge between them. This ridge is a part of the original plane surface of the end of the base and it lies in the plane of the horizontal, sliding scale. The instrument is shown as employed in determining changes in the torsion angle.

median epicondyle, on the left side this movement is increased to nearly 3 mm. There are, however, a number of individual cases in which the upper end of the bone moves outward, increasing the angle of obliquity. As these cases are somewhat more numerous among the right bones the

net result is a lowering of the mean values for the right side, since the inward and outward movements tend to cancel each other in the computation of the mean. It should be noted that in all instances cases showing no change in obliquity have been grouped with those in which the obliquity is decreased. The mean values of the latter are therefore a trifle lower than they would otherwise be. On the right side about 23% of cases show this outward movement to the extent of 2.5 mm. as a mean, the remaining cases move inward about 3 mm. On the left 17% move outward, but slightly less than on the right, while the remainder move inward nearly 4 mm. In this swinging to and fro the right appears rather less stable than the left.

Although the number of colored cases is too small to warrant any very definite conclusions, their behavior throughout is so different from the white that the results do not seem to be due entirely to chance sampling.

In the male colored the mean inward movement of the upper end of the bone is distinctly less than in the male white, but like these it is more marked on the left; the mean figures being a little less than 1 mm. on the right and little more than 1.5 on the left. These low results are due to the fact that in nearly half the cases there is no inward movement at all but instead a movement in the opposite direction. In the group of cases showing an decrease in the angle of obliquity the upper end of the bone moves inward on an average of about 4 mm. the displacement being slightly less extensive on the right. In the other group the outward movement is about 3 mm. with no material differences on the two sides.

The female colored shows conditions much like the male but they are rather exaggerated on the left side. The mean displacement of the upper end on the right is inward by 2 mm. or a little less. This is even more than occurs in the male white, and is accounted for by the fact that four of the seven cases move inward for an average of 5 mm. The remaining 3 moving outward by about 2.5 mm. On the left side, the tendency of the colored bones to swing outward, after removal of the cartilage, seems to reach its maximum, where four out of the seven show this peculiarity. Not only do a majority of the bones show this but their mean outward movement is nearly 2 mm., while the opposite movement of the remainder is only about 1.6. The mean result for the left bones in the female colored being a slight outward movement, less than 0.5 mm.

The interpretation of these results in terms of the infracondylar cartilage is quite simple. If the cartilage on the two bearing surfaces of the condyles were of equal thickness there would be no alteration in the angle of obliquity as a result of the removal of this cartilage. Such

cases occur but they are not numerous. If the cartilage of the inner condyle is the thicker, then removal of all cartilage will cause the upper end of the bone to swing inward as the inner condyle takes up a lower position, the whole bone moving around the outer condyle as a center. If, on the other hand, the cartilage on the outer condyle is thicker, conditions will be reversed and the upper end of the bone will move outward. In both cases the result is a movement of the upper end of the bone toward that condyle which had the thicker cartilage.

Viewed in this light our measurements would indicate that in male whites the infracondylar cartilage on the median condyle is thicker than that on the lateral condyle in about 75% of cases. In the majority of the remaining cases the cartilage is thicker on the lateral condyle, but the excess here does not reach the proportion seen on the median condyle. In a few instances there is no difference in thickness on the two sides.

The distinguishing features in the colored material are the greater variations in the thickness of the cartilage and also the frequency with which the cartilage on the lateral condyle exceeds that on the median in thickness. In almost 50% of the cases—not including the female left—the lateral condyle possessed the thicker cartilage. The mean excess, however, still remains in favor of the internal condyle. Not only is the cartilage more variable, but we believe that it is absolutely thicker than in the male white as is indicated by the extent to which upper end swings inward or outward. This is especially marked on the right in the female, where the shorter bones would tend to lessen the effect of the cartilage. The peculiarity of the left female bones is that in the majority of the series the cartilage was thicker over the lateral condyle, but in absolute thickness, it seems to fall short of the right side.

As regards the absolute thickness of the infracondylar cartilage we can make no definite statements. Concerning the difference in thickness on the two condyles however, it is possible to give some more tangible results. Judging from the tests we have made on dry femora, by raising or lowering one of the condyles and noting the displacement of the upper end, we would say that differences of 1 mm. in the thickness of the cartilage on the infracondylar plane are comparatively frequent, but by no means the rule. The mean difference in thickness lies between 0.5 and 1 mm. and rather nearer the former figure. Considering the amount of deviation of the head and great trochanter from their original positions, due to the removal of cartilage, the excess in thickness of cartilage on one condyle, must, in some cases, rise to 1.5 mm. or even more. The mean effect of these variations in the thickness of the cartilage is to

decrease the angle of obliquity by about 0.5°, the range being from 0.0° to nearly 2° on either side of the original position.

Changes in the angle of the shaft react in turn upon the oblique and oblique trochanteric lengths. If the angle is reduced, i. e. if the bone assumes a more vertical portion, both these dimensions are increased, but the latter more than the former. Increase in the angle would bring about the opposite result. In any case the magnitude of the initial angle is the most important factor because the effects of alterations in it increase as the angle increases. However, it does not appear possible to determine for a cartilage free bone whether the cartilage was thicker on the median or lateral condyle, i. e. whether in the recent state the bone was more or less oblique and therefore shorter or longer in its oblique dimensions. We may therefore confine our remarks to average conditions.

In male whites from 0.5 to 0.75 mm. of the loss in the oblique trochanteric length is regained as a result of the decrease in obliquity of the shaft. Only about half this amount, or a little better, is regained by the oblique length. If the thickness of the cartilage over the median condyle exceeds that on the lateral by 1 mm. than it would be necessary to double the values just noted. An increase in obliquity, as would occur in those cases in which the cartilage of the lateral condyle was thicker, would have the opposite effect. In the colored material, where it is about an even chance as to which condyle might have had the thicker cartilage, there is ample opportunity for an error of from 2 to 4 mm. in any attempt to determine the oblique lengths in the recent state from the dimensions of the cartilage free but *fresh, unmacerated* bone. From the foregoing it is evident that the reconstruction of the dimensions which obtained during life can at best be only approximate, with the possibilities of error, large and varied.

Another effect of these changes in the angle of the shaft, is that, unless there are some compensatory changes elsewhere, as for example in the knee joint or hip joint, there would result alterations in the distance between the heads of the femora, which in extreme cases might reach 20 mm. or even more.

Removal of the cartilage on the retrocondylar plane is without significant effects upon the mean angle of torsion. Changes in this angle were determined by the use of the altimeter as noted above but no angular measurements were taken. Very often there is no change whatever in the angle, and nearly as often there is a slight increase indicating that the cartilage on the lateral condyle was a trifle thicker. Rather more common than either of these conditions is a small decrease in the

torsion angle as we have determined it. The only differences which can be made out between the white and colored material is, in terms of cartilage, the tendency, in the former, for the cartilage to be of equal thickness in the lacks of the two condyles or else thicker on the medial condyle.

These results fall into line with what has been found in regard to the infracondylar cartilage as indicating a greater constancy of form and thickness in male whites as compared with the colored of both sexes.

PROJECTED LENGTH OF THE CONDYLES

TABLE 3.

		Mean	Mean loss	Percentage loss	Range of loss Min.	Max.
Lateral Condyle, Projected Length						
Male, white 36 cases	Right	69.61	3.03	4.36	2.25	4.5
	Left	69.64	3.03	4.36	2.0	4.0
Male, colored 10 cases	Right	72.2	3.85	5.33	2.75	5.0
	Left	71.7	3.55	4.95	2.0	5.25
Female, colored 7 cases	Right	65.43	3.46	5.29	2.0	4.75
	Left	64.86	3.57	5.50	1.5	4.5
Median Condyle, Projected Length						
Male, white	Right	65.86	2.82	4.28	1.75	4.75
	Left	65.69	2.66	4.05	1.5	4.0
Male, colored	Right	67.9	3.05	4.49	2.0	4.75
	Left	67.8	3.1	4.57	2.5	4.0
Female, colored	Right	61.86	2.68	4.33	1.5	4.0
	Left	61.57	2.46	3.99	0.5	3.5

The measurements in these cases have been taken in the usual manner, parallel to the infracondylar plane, and with all the cartilage in place, after removal of the cartilage on the ventral surface only, and again after the removal of the retrocondylar cartilage as well.

The mean loss in the projected length of the lateral condyle, for all of our material after the removal of all cartilage, is 3.22 mm. or 4.6% of the original length. The loss in the white material is somewhat less than in the colored cases, 3.03 mm. as compared with 3.62 mm. Another difference is that while the white material shows identical values on the two sides, the male colored shows a slightly greater loss on the right, the female on the left. As indicative of the thicker cartilage in the colored it may be noted that, in spite of a longer lateral condyle in the male colored as compared with the white, 71.95 mm. against 69.62, the percentage loss in the former is distinctly greater, in the female colored the loss is even more pronounced. The decrease in length is due to the removal of two layers of cartilage, one from the posterior and the other from the anterior surface of the condyle. In the latter location, the cartilage in question is on the extreme lateral edge the patellar groove and is subject

to considerable variation. It varies in thickness from 0.25 to 2 mm. in the male white, from 0.25 to 3.75 in the male colored and from 0.5 to 3 in the female colored, the corresponding means being 1.15, 1.58 and 1.89 mm. respectively. In the white the two sides are practically identical, while in the colored the right shows slightly higher values. The relation of the cartilage on the ventral surface to that on the posterior varies in the three groups of cases. Of the mean total thickness, two layers, which help make up the projected length of the lateral condyle in the recent state, 38% in male whites is on the ventral surface, 43% in the male colored, and 54% in the female colored. The mean thickness of the remaining cartilage, on the retrocondylar plane, is for the same groups 1.88, 2.12 and 1.62 mm.

As a rule the median condyle is shorter than the lateral in its projected length, and the cartilage involved is not only absolutely but also relatively thinner than it is on the lateral condyle. On the median condyle the mean loss in length, after all cartilage has been removed, is 2.74 mm. in male whites, 3.1 in the male colored and 2.57 in the female colored. Like the conditions on the lateral condyle the percentage loss is greater in the male colored than in the white, but unlike these the loss in the female colored is more like the condition in the male white. In general, and this holds for both median and lateral condyles, the minimum losses, or the thinnest cartilage, are found on the left side, the maximum losses on the right side.

On the ventral edge of the median condyle the cartilaginous covering is distinctly thinner than over the ventral margin of the lateral condyle. In the male white it varies from 0.0 mm. to 2 mm. in the colored male from 0.25 to 2, in the female colored from 0.0 to 1.75, the corresponding mean values being .74, .83 and .96 mm. and in all cases the cartilage on the right is rather thicker with the difference most marked in the female. Of the mean total thickness of the cartilage which is concerned in the projected length of the median condyle, 27% is on the ventral surface in the male, both white and colored, 37% in the female colored. The mean thickness of the remaining layer, on the posterior surface is 2, 2.19 and 1.6 mm. for the same groups of cases.

The effects of the two layers of cartilage upon the projected length of the condyles comes out very clearly if one determines the indices commonly employed in dealing with dry bone. We have computed the condylar index and the condylar lengths index but using the projected length instead of the maximum length of the condyles as was done in our first article on the femur. The former, the condylar index, is the percentage value of the lateral condyle, in this case the projected length, in

terms of the epicondylar breadth, the formula being—lateral condyle, projected length, x 100 / epicondylar breadth. This index has been determined with the cartilage intact and after its removal, reference in all cases being to indices of means and not mean indices. The results, for combined right and left, and all cartilage present, are as follows: male white 82.39, male colored 84.35, female colored 89.11. The rise in the value of the index is due mainly to the greater length of the condyle in the male colored, and the smaller epicondylar breadth in the female. In male whites the index is slightly higher on the left, 82.71 as compared with 82.09. For the cartilage free bone the same rise in indices is observed, and the differences between the two series rises in the same manner. There is a natural lowering of the index due to shortening of the condyle by the removal of cartilage. The indices for the groups just noted are 78.71, 79.89 and 84.13. The relatively thicker cartilage in the colored, especially in the female, is responsible for the more pronounced fall of the indices in these cases. In the male white the indices for right and left are 78.42 and 79.01.

The condylar lengths index is the percentage value of the lateral condyle in terms of the median condyle, the projected length being used instead of the maximum length. The formula is, lateral condyle, projected length, x 100 / median condyle, projected length. Increase in the values of the index is indicative either of longer lateral or a shorter median condyle. The removal of all cartilage results in a lowering of the index because the lateral condyle has lost relatively more cartilage than the median. The indices of means, for combined right and left sides are, with all cartilage in place, in male whites 105.81, after removal of the cartilage the index is reduced to 105.58. The corresponding figures in the male colored are 106.12 and 105.49; in the female colored 105.58 and 104.06. In both groups of colored cases the index has suffered a greater reduction than the white due to the greater relative thickness of the cartilage removed from the lateral condyle. This is especially true for the female in which the relative lengths of the condyles in the recent state bear essentially the same relation to each other as in the male after the removal of the cartilage. In addition to these differences it may be noted that, as regards right and left, the male white shows the higher indices on the left, the colored material on the right and this regardless of the presence or absence of cartilage. Further comparison indicates that the differences in index between right and left are practically identical when the cartilage is in place, but in the white the higher value is on the left, while in the colored it is on the right. Comparing, however, the indices for right and left after removal of the cartilage, one

finds that in the male white they are identical, in the male colored they differ in the same direction and extent as in the recent state, but in the female colored the difference while being in the same direction is more than twice that with intact cartilage. In other words, the relative lengths of the condyles in the recent state, i.e. in their normal functioning condition, is determined in the male white by the cartilage rather than by the bone, in the colored female the bone is the main determining factor, in spite of the thick cartilage. In the male colored the cartilage practically repeats the bony characters.

There are some additional observations on the condylar region which have less direct bearing on any femoral dimensions but concern rather local variations in the relations of cartilage and bone. While collecting the data already discussed we have also noted the distance between the lowest point on the two condyles, both with and without cartilage, and the plane of the median epicondyle. The latter plane is tangent to the median epicondyle and at right angles to the infracondylar plane in which the measurements were taken. In this way we have determined the relative positions of the lowest points, on the convexity of the articular surface, both with and without cartilage, i.e. whether the lowest point on the cartilaginous surface corresponds with that on the bone or lies internal or external. As regards antero-posterior displacements we have no information. Since great accuracy cannot be claimed for measurements of this character, we shall treat the results rather briefly.

On the lateral condyle, in male whites, the convexity of the cartilage where it is tangent to the infracondylar plane, may be over the corresponding point on the bone but this is unusual. The cases in which it is either inside or outside are about equal in number, and the displacement in either direction reaches 5.5 to 6 mm. in extreme cases. The mean result is that there is practically no displacement whatever, although individual cases of this kind are uncommon. Considering the two groups which show either an inward or outward displacement, the mean for each group is 1.9 mm. In the colored material, the most obvious feature is the preponderance of those cases in which the convexity of the cartilage lies lateral to the corresponding bony point, most pronounced in the female on the left side. In the male colored the net result is an outward displacement of .5 mm. in the female 1.4 mm. The range of displacement may be a little greater in the white than in the colored.

On the median condyle the relations of cartilage to bone, as defined above, are much more constant. In only four cases, in all of the material, does the convexity of the cartilage lie medial to the convexity of the bone, and all of these occur in whites where the greatest displacement is

only 1 mm. The mean outward displacement for the remaining cases, white material, is 2.2 mm. the range being from 0.0 to 6.5 mm. The colored cases differ from the white not only in showing no cases of inward displacement, but the mean outward displacement is much higher, 3.37 mm. in the male and 3.25 in the female. These higher values are not due to a greater displacement in individual cases, the upper limit being 7.5 mm. in the male but only 5 in the female; but rather to the fact that the lower limit is raised, there being only one case below 2 mm. For both condyles, therefore, there is a greater tendency in the colored to shift the convexity of the cartilage to a point lateral to the convexity of the bone.

Aside from alterations in the curvature of the condyles, the mean result of the displacements of cartilage on the bone is that the distance between the convexities of the two condyles is slightly less with the cartilage in place than after its removal, the decrease being a little more conspicuous in the colored than in the white. With cartilage intact, the mean distance between the points on the two condyles, tangent to the infracondylar plane, is 50.6 mm. in males, both white and colored, and 42.9 in the female colored. The mean distance between the bony points is 52.7, 53.9 and 46.2 mm. for the same cases, all for right side.

The remaining observations on this part of the bone concern the patellar surface, where we have determined the distance from its concavity both to the retrocondylar plane and to the plane of the median epicondyle. The decrease in the distance from the deepest point of the patellar surface to the retrocondylar plane due to the loss of cartilage and measured parallel to the infracondylar plane, is remarkably constant. The absolute values are 4.44 mm. in the male white, 4.75 in the male colored and 4.48 in the female colored. The percentage reductions from the original fresh dimensions are 7.1, 7.3 and 7.6 respectively. The above figures do not represent actually the thickness of the cartilage removed, which is rather less, since the deepest points in bone and cartilage do not correspond. The mean position of the deepest point on the bone is a little internal to the corresponding point on the original cartilaginous surface. There is considerable shifting inward and outward of the deepest point in the cartilage as compared with the bone, commonly from 3 to 4 mm. in either direction, but these figures are occasionally doubled, in a few cases the deepest points coincide. The mean outward displacement of the concavity of the cartilage is .7 mm. in the male white, .05 in the male colored and 1.55 mm. in the female colored. As contrasted with the male, both white and colored, there is only one instance in the female and on one side, in which the deepest

point of the cartilage lies internal to the deepest point on the bone. The mean effect of the cartilage on the patellar surface is to bring the deepest point of the articular surface further from the mid-line of the bone, and nearer the lateral limits of the joint.

THE DIAMETER OF THE HEAD

TABLE 4.

		Mean	Mean loss	Percentage loss	Range of loss Min.	Max.
		Head, Vertical Diameter				
Male, white	Right	51.87	1.93	3.72	0.25	3.0
36 cases	Left	51.67	2.03	3.93	1.25	3.0
Male, colored	Right	50.32	2.15	4.27	1.75	3.0
10 cases	Left	50.15	2.02	4.03	1.5	2.5
Female, colored	Right	43.71	1.96	4.49	0.25	2.75
7 cases	Left	43.89	2.32	5.29	2.0	2.75
		Head, Horizontal Diameter				
Male, white	Right	51.42	2.29	4.46	1.5	3.25
	Left	51.09	2.15	4.21	1.0	3.0
Male, colored	Right	50.17	2.3	4.58	2.0	2.75
	Left	50.1	2.2	4.39	1.75	3.0
Female, colored	Right	43.64	2.36	5.41	1.75	2.75
	Left	43.72	2.21	5.06	1.75	2.50

The role of the articular cartilage in determining the dimensions of the head of the femur is evident from the preceding table. There is a steady decrease in the mean diameter of the head as one passes from the male white to the female colored. Since the mean loss due to the removal of the cartilage varies but little in the three groups of cases, the resultant percentage loss rises progressively as the diameter of the head diminishes. This percentage loss is consistently less for the vertical than for the horizontal diameter, except on the left side in the female colored. This would indicate, as is also evident from the mean losses, that the two layers of cartilage on the anterior and posterior surfaces of the head are, taken together, thicker than the layers above and below. Two factors might be of importance here, one, the better fit over the top of the head where the weight is carried, and two, the relatively lower requirement for cartilage on the opposite, under surface of the head. The mean loss in the vertical diameter of the head in male whites is 1.98 mm. in the male colored 2.08, and in the female colored 2.14, while the corresponding percentage losses are 3.82, 4.15 and 4.89. For the horizontal diameter the mean losses are 2.22, 2.25 and 2.28 mm. which correspond to percentage losses of 4.33, 4.48 and 5.23.

The effect of the articular cartilage in modifying the form of the head is shown by the primary capital index of Pearson, as indicating the ellipticity of the head in a plane at right angles to the axis of the neck. The formula for this index is horizontal diameter x 100 / vertical diameter. If the index is 100 the head is circular in the plane measured, if

below 100 it may be described as elliptical with the major axis in the vertical position, i.e. the head flattened from before backward. Indices above 100 would indicate a flattening from above downward. In general, the effect of the cartilaginous covering is to decrease the ellipticity of the head, or to render it more nearly circular in the plane mentioned, bringing the index nearer to 100.

TABLE 5.

Primary Capital Index
(Index of Means)

	Male, white		Male, colored		Female, colored	
	Right	Left	Right	Left	Right	Left
Cartilage intact........	99.07	98.82	99.75	99.95	99.87	99.60
Cartilage removed......	98.48	98.66	99.33	99.64	99.18	99.76

The extent and manner in which the cartilage modifies the form of the head may be seen in Table 5. In only one instance is the index higher after the cartilage has been removed, on the left side in the female colored, but this may be due, in part at least, to the small number of cases. The most conspicuous feature is that the head of the femur is more nearly spherical in the colored material than it is in the white regardless of the presence or absence of cartilage. Indeed the head of the bone in the colored is more spherical after the removal of the cartilage than in the white before its removal. The mean indices for right and left, in the three groups of cases are, 98.94, 99.85 and 99.73 in the recent state; and 98.57, 99.48 and 99.47 for the cartilage free bone. As far as the means are concerned, the heads in all groups show a slight antero-posterior flattening, but this is most marked in the male white where even the addition of cartilage does not relieve it materially. The difference in the indices of the males, white and colored, with cartilage intact, corresponds to a major axis, or vertical diameter, about .5 mm. longer than the minor axis in the male white. This is approximately 1% of the diameter of the head.

It does not seem necessary to discuss at length the results of Hellwig's[1] detailed investigations on the form and dimensions of the femoral head before and after the removal of the cartilage. His methods are entirely different and the head is measured not only in a different plane but the position of the plane varies from one case to another. In general he finds the head either spherical, 30%, or a part of rotation ellipsoid, 70%, the long axis of which forms a small but varying angle with the axis of the neck of the femur. In the latter, and more numerous cases, a section through the head in a frontal or horizontal plane gives the outline of an

[1]R. Hellwig. Ueber die Form des menschlichen Hüftgelenkes. *Intern. Monatsschr.*, 1918, XXXII.

ellipse; sections in a sagittal plane, i.e . through the minor axes, give in all cases a circle. Judging from Hellwig's diagrams we believe that, in many cases, the diameters of the head as usually taken would correspond fairly well with his minor axes, which he apparently finds of equal in all cases. In other words he finds the head circular in a plane very close to one in which other investigators find it distinctly elliptical.

With due regard for varying methods we cannot agree with Hellwig in two important points. In the first place we do not believe that the head of the femur is as constantly circular, in a plane roughly at right angles to the axis of the neck, as his results would indicate. The usual form shows a slight but, definite antero-posterior flattening, although spherical heads doubtless occur. It has seemed to us possible that in his determinations, by optical section, his sagittal section or minor axes, might have cut an elliptical head in such a manner that the result would be a circle. This seems all the more possible since the major axis swings back and forth in the neck through 30°. Any section of a spherical head would, of course be circular in form.

The second point where we fail to agree is Hellwig's statement (l. c. pg. 148) that the articular cartilage is without effect upon the form of the head; and ellipsoid remaining an ellipsoid, a sphere remaining a sphere. There is no reason whatever why the form should remain the same, especially since the bony head is not really spherical. The role of the cartilage is to form suitable articular surfaces but always with regard to the needs of the particular joint in question. On the head of the femur its effect, but perhaps not its primary role, is to render more spherical a bony surface, which, for other reasons, has a tendency, perhaps an increasing tendency, to undergo some antero-posterior flattening.

The relative size, in the recent state, of the head and condylar region in our three groups of cases is indicated by the capito-bicondylar index or the 3rd capital index of Pearson, for which the formula is, head, vertical, diameter, x 100 / epicondylar breadth. The indices of means, for the right and left sides taken together, are as follows; male white 61.3, male colored, 58.9, female colored 59.9. A lower index is indicative of a smaller femoral head or a greater epicondylar breadth, the latter character accounting in part for the low index in the male colored. Further evidence that the colored material is characterized by a relatively small femoral head and large condyles is furnished by a comparison of dimensions of these two joints. For this purpose we have computed what may be termed the external and internal capito-condylar indices, the formula of the first being head, vertical diameter x

100 / lateral condyle, projected length; the dimensions of the median condyle being substituted for the second index. The results are 74.4 and 78.7 for the male white, 69.9 and 74.1 for the male colored and 67.3 and 70.9 for the female colored. When compared with the capito-bicondylar results, these last indices indicate that the disproportion in the region of the knee is more accentuated for the condylar lengths than for the epicondylar breadth, with a slight excess for the median condyle.

To what has already been noted, as to the effect of articular cartilage upon those femoral measurements in which it is concerned, there is little to be added. The alteration due to the removal of cartilage, or better, the remodeling of the bony joint surface by the articular cartilage is of interest and importance only if it can be viewed in terms of the function of the particular bone or joint. Both bone and cartilage, as well as the soft parts, play their own role in the mechanism of the living joint, and the whole story of joint movements can certainly not be told by the dry bone alone. It is because we have been dealing in the investigation with bones, substantially as they were during life, still in possession of many of their functional characters and therefore able to give additional evidence as to their possible or probable use, that the present study has been of special interest to us. In view of the role of articular cartilage, one would expect that the variations and differences which have been encountered would admit of some functional interpretation.

Without going into too much detail, or distinguishing at present between male and female colored cases, our own opinions, in part speculative, as to the distinctive features of the white and colored material, may be formulated somewhat as follows.

The thicker cartilage in the colored and its greater variability give one the impression of a joint rather less finished and less stereotyped than in the white. Both of these characters would indicate a joint in which the bony apposition is less accurate, if not also less adequate, or, in addition, a joint in which there are special demands upon cartilage of sufficient degree to call forth distinctive characters. In any case these differences must resolve themselves into questions of use, including the various possibilities and limitations to which the joint may be subject. It is not a question of the weight or pressure which any cartilaginous surface may be called upon to support, but rather of the forces which tend to deform and mold the cartilage from moment to moment, thereby subjecting it to variety of internal strains, which in their turn are largely responsible for the thickness of the cartilage at any given point. We do not mean to imply that the knee joint, for example is not as good a joint in the colored

as in the white. The evidence from the cartilage, as we see it, seems to indicate that both the hip and knee joints in the white are constructed with somewhat greater accuracy and precision. The movements carried out at these joints would be more definitely and constantly of a certain character, varying within narrower limits. A greater specialization, if one may be permitted to use the term, for a smaller range of movement on the one hand, but especially for greater security or stability on the other. In this sense the white joint would represent an advance over the colored. One of nature's most difficult problems in the development and maintenance of the erect posture has been the mechanism of the knee joint. Many alterations have been made in order to secure the proper combination of mobility and stability, the tendency at present being to sacrifice the former to insure the latter. The greater constancy of the cartilage in the white material finds a parallel in the internal architecture of bones. The definiteness and constancy of structure in the same bone in different forms is directly related to the definiteness and constancy which the strains are applied to the osseous tissue. If these stresses vary widely in range and character the reaction of the bone is correspondingly indefinite or generalized. If these forces fall within comparatively narrow limits, due to limitations of use or by habit, or for any other reason, then the bone will naturally adapt itself to the stronger forces, i.e. to the more constant and continuous stimuli, by taking on a correspondingly definite and appropriate structure.

From this point of view it is possible to interpret, in a general way, many of the differences exhibited by the colored material, the greater contrast being provided by the female. Since we have no female white material we can only contrast the colored with the male white and it is quite possible that the female white would show some differences from the male.

For the knee joint, the conditions favoring rotation of the tibia on the femur seem more conspicuous in the colored. Here may be noted, the greater thickness of the cartilage on the lateral condyle which has the greater range of movement, also the relatively greater length of this condyle, especially with the cartilage in place. The narrowing effect of the cartilage upon the bearing surfaces of the condyles, as well as the longer condyles, or relatively narrower joint would be more favorable to rotation than to mere flexion and extension or general stability. Complete extension of the leg is accompanied, in the final stages, by a slight, but definite outward rotation, or supination of the leg. This last adjustment of the joint mechanism is of the utmost importance for the dependability of the knee in complete extension. In this movement it is

the medial instead of the lateral condyle which is concerned, the condyle sliding backward on the medial condyle of the tibia to undergo a sort of locking in its new position. In harmony with this is the thicker cartilage of the medial condyle in the white as well as the greater length of this condyle.

As regards the head of the femur it is not possible to be so specific. Its smaller size in the colored can hardly make for stability but rather for increased range and freedom of movement. The fact that it is more spherical, even after the cartilage has been removed, is evidence which points in the same direction. The departure of the heads of the white material, from the more regular spherical form of the colored, would indicate that, while, the possibilities for range or variety of movement may not have been compromised materially, the change in form is to be looked upon as the result of a relative restriction, or the increasing preponderance of certain positions or movements within narrower limits, and of such a character and constancy as to gradually bring about the antero-posterior flattening of the head.

Viewed as a whole, the joints with which we have been dealing appear somewhat more advanced in the white than in the colored. The advances are largely in the nature of restrictions and in lessened variability, in the tendency to forego freedom of movement for additional security. That these features are most conspicuous at the knee joint is the natural result of its extreme importance, and of the inherent difficulties in its proper stabilization.

LITERATURE

EVOLUTION. AMERICAN POPULATION

THE CHAIN OF LIFE. By Osborn (Lucretia Perry)—8°, N. Y., 1925, pp. xvi, 189, numerous illustr's (Charles Scribner's Sons, $2).

The writing of a book on Evolution by Mrs. Osborn, the wife of Henry Fairfield Osborn, may seem like carrying coals to Newcastle. Nevertheless, Mrs. Osborn has produced a most readable primer on the subject, which will doubtless be read and appreciated by many people who do not have time or inclination for more technical treatises. The book is not only well written—it could hardly be otherwise—but is both reliable and instructive throughout, the latter quality being supplemented by numerous, mostly original, illustrations.

Very correctly, the author speaks no more of evolution as a theory: it is "a law as fixed as gravitation." The processes and methods of evolution are also more or less perfectly known. The causes of evolution however are still only partially clear, and ,"this is the only debatable part of evolution to-day."

The extent of the treatise will best be seen from the Contents: Introduction; Where did life come from? How did life originate? The beginning of evolution; Fishes and amphibians; Reptiles; The rise of the birds and mammals; The age of mammals; The rise of man; and Man.

If any regrets are to be expressed they are that the chapter on Man could not have been more ample; and that it was thought necessary to include two examples of the now over familiar restorations of earlier man. These restorations, good as they are, are, it seems, getting somewhat on the readers' nerves and there is a yearning for more variety.

POPULATION PROBLEMS IN THE UNITED STATES AND CANADA. Edited by Dublin (Louis I.)—Publications of the Pollak Foundation for Economic Research, No. 5, 8°, 1926, pp. xi, 318 (Houghton Mifflin Co., Boston & N. Y., $4.00).

This is a compilation of important scientific papers on American population, presented before the American Statistical Association, under the presidency of Dr. Louis I. Dublin, in 1924. It comprises, besides others, the following papers of more direct interest to American physical anthropology: Dublin (L. I.)—The Statistician and the Population Problem, 3–18; Reuter (E. B.)—Population Growth in the United States, 19–32; Thompson (Warren S.)—Natural Increase of Population, 33–51; Hart (Hornell)—Urbanization of Population, 52–62; Wolfe (A. B.)—The Optimum Size of Population, 63–76; Taylor (A. E.) —Agricultural Capacity and Population Increase, 94–110; Fairchild (H. P.)—Racial Composition of the Population, 141–152; Hrdlička (A.)—Effects of Immigration on the American Type, 153–166; Husband (W. W.)—A Rational Immigration Policy, 167–175; Coats (R. H.)—The Immigration Program of Canada, 176–194; Goldenweiser (A.)—Immigration and National Life, 195–212; Holmes (S. J.)—Effect of the Health Movement on Future Population, 257–272; and MacIver (R. M.) —Trend of Population with Respect to a Future Equilibrium, 287–312.

Mongrel Virginians. By Estabrook (Arthur H.) and Ivan E. McDougle—sm. 8°, 205 pp., Baltimore, 1926 (Williams & Wilkins Co., $3.00).

The book "presents the results of a four year investigation by two trained observers, one a eugenist and the other a sociologist." The subject of the studies was a "group of Indian-negro-white crosses who have lived in the same locality for over a hundred years," and on which there are exceptionally good records. This is the "Win Tribe" of the foothills of the Blue Mountains, Ab Co., Va. The authors deal with the history of this group; the White Brown Family; the Indian Browns; the Indian Jones; Population; Fecundity; Consanguinity; Legitimacy; the Sex Mores; Alcoholism; Venereal Disease and Tuberculosis.

This general report shows that "there has been and still is much mating between the Indian, the Negro and the white races in the South. There are a number of spots where Indians lived previous to the Revolution and, because they were 'dark-skinned' they were prevented in the main from having social relations with the white. Here and there a white man mated with some Indian woman. Sometimes these matings were by marriage, often illegitimately. The resulting offspring were still dark in color. In the early part of the nineteenth century the race prejudice against the negro became stronger and all dark skinned persons were therefore included in the ban. Their classification became 'persons of color'. This naturally threw the Indian and the negro closer together although the former had always felt himself superior to the negro. As early as 1830 we find Indian-negro matings taking place among the Rivers in North Carolina. Many of the Indians had already mated with the whites. This completed the triple mixture of the races. Since then intermixing has continued with the results shown in the foregoing description.

"It is evident from this study that the intellectual levels of the negro and the Indian race as now found is below the average for the white race. In the Wins the early white stock was probably at least of normal ability, i. e. for the white. After the mating of this white Brown stock with the Indian, the general level of the white was lowered in the mixing. Since that time the group has mated either into itself, into negro stocks, which are necessarily below the level of the whites, or into white stocks which are known to be below the average mental level. Only one mating of better white stock into the Wins has taken place in more recent years, that of Amelia Brown, and the two resulting offspring, two women, have been of better calibre than the general run of the Wins. One of these two women had children and these three have been more energetic and active than the vast majority of the whole group.

"The whole Win tribe is below the average, mentally and socially. They are lacking in academic ability, industrious to a very limited degree and capable of taking little training. . . In their social relationships they represent a very crude type of civilization. With early adolescence and no social restrictions, excluding the influence of the one church mission, there is great sexual freedom with considerable illegitimacy and even promiscuity after marriage. They have of their own

free will developed no means of amusement for themselves and life appears to drag along from day to day in the same old dreary way.

"The persistency of Indian traits among the Wins appears remarkable when the remoteness of pure Indian blood is taken into consideration. When one sees a group of men walking along the county road they will always be found parading in single file and for the most part non-communicative. They are all very suspicious but this may be largely due to their geographical and their even greater psychological isolation throughout life. For the most part they are extremely diffident, reserved, timid, graceless, taciturn and very humble. There is practically no music among them and they have no sense of rhythm even in the lighter mulatto mixtures. . . Unquestionably the people covered by this study represent an ever increasing social [and anthropological] problem in the South."

Anthropometric, physiological and strict pathological data are regrettably lacking.

THE MELTING POT MISTAKE. By Fairchild (Henry Pratt)—8°, pp. vi, 266, Boston, 1926 (Little, Brown & Co.).

In the introductory words of the Editor, this book "answers, in the light of recent research, those questions that persistently arise regarding the effect of immigration on the vigor and permanence of our life as a nation."

It is a general discussion, mainly sociological. While superior in some respects, the book attaches itself nevertheless to the well-known line of books published on much the same theme in recent years by Scribners.

The author finds some stones of incidence when he approaches physical anthropology. He does not believe in much unification by mixture. "All true racial traits are exclusively hereditary. . . No racial trait can ever be acquired, nor can it ever be lost by an individual as a result of the experiences of his lifetime" (p. 27). "Of the various indices in use, probably the most important is what is known as the 'cranial' or 'cephalic index,' which is the proportion (expressed in percentage) between the greatest breadth and the greatest length of the skull *looked at from above*. Others are the proportion between the greatest breadth and the greatest height, *looked at from in front*" (pp. 30–31: Italics by the reviewer). "Apparently the process of race formation stopped long ago," etc. (p. 33). The Nordic race does not escape its usual eulogy.

The best chapter of the book is that on Nationality and nationalism. The author well recognizes the preponderating role played by this factor in the world of to-day. There is also much to commend in the chapter on "A Nation in the Making;" but following that there is the "New Menace" and other chapters which endeavor to show the peril of the later immigration to America.

The book is very readable and on the whole represents an earnest and not unapt effort at a contribution towards the solution of the population problems of this country.

VARIATION: BODY; ORGANS; SOFT PARTS

THE HEREDITY OF UNILATERAL VARIATIONS IN MAN. By Danforth (C. H.)—*Genetics*, 1924, IX, 199–211.

"Definite variations are found to occur with an average frequency of from 7 to 9 per cent in a series of individual anatomical structures which are ordinarily classed as bilaterally symmetrical. Most of these variations find a bilateral expression in some individuals and only a unilateral expression in others. Several lines of evidence indicate that both the bilateral and the unilateral cases are commonly germinal in origin, and in some cases their heredity has been established. So far as the evidence goes there is no indication that the unilateral appearance of a variation differs genetically from the bilateral. There is some evidence that most of these traits may best be considered as due to modifying factors that interact with more fundamental determiners for which the species may be homozygous. Each type of gene has its peculiar degree of potency, which in most cases is such as to admit of certain failures of the trait to appear. This is of considerable importance in genetic analysis, since not infrequently the non-appearance class may be of appreciable size. The sides of the body and the sex of the individual act as definite influences in favoring or tending to inhibit the appearance of various traits represented in the germ-plasm."

GOOD POSTURE FOR WOMEN. By Goetz (Alice L.)—*Am. Phys. Educ. Rev.*, 1926, XXXI, No. 1, 596–606.

"Many young and also older women have poor posture. With some it is a posture of indifference or carelessness—the "debutante slouch" . . . With other women we find a fatigue posture; weariness of body or mind, or both, due to some of the many causes which prevent them from being their best physically." There are also overdone postures. All of which is excellently illustrated by black silhouettes. The bulk of the timely and good article is devoted to methods of correction.

EL OLOR COMO CARÁCTER DE LAS RAZAS HUMANAS. By Barreiro (P.)—*Actas y Mem. Soc. Español. Antropol.*, 1924, III, No. 3, 153–159. (Madrid, Mus. Antrop. Nacional).

The author discusses the interesting and rather neglected subject of racial odours. The normal odour of the body varies considerably from race to race, as well as to a lesser degree among individuals. Such odours are perceived better in the members of another race or family than in one's own. The colored races seem to possess a more acute olfactory perception than others, though even the latter perceive clearly the differences between the negroes and the yellow-browns or whites. In the belief of the author the racial odour is sensible to those of other racial groups in proportion to the difference between the two. The differences in the odour have a chemical basis. In illustration the author quotes various references from literature.

The subject of racial and particularly the negro odour deserves thorough scientific attention.

Das Problem der Rechtshändigkeit vom geologisch-paläontologischen Gesichtpunkt betrachtet. By Klähn (Hans)—8°, 86 pp., Berlin, 1925 (Borntraeger).

Basing himself on literature, which is not always the surest and all-sufficing method, the author reaches a number of conclusions on the subject he deals with, which do not seem fully to correspond to skeletal evidence and lack corroboration by direct research. For him, right-handedness is a "typical *human* property." It was absent in the anthropoid apes, "who show no trace of a functional differentiation in favor of the right hand." Lefthandedness is no atavistic condition; it was rarer in ancient man and is less frequent in primitive races than it is in modern European man. Most of the present lefthandedness in the European is of abnormal or pathological nature. Righthandedness developed as a result of progressive complexity of function.

All of which, in the opinion of the reviewer, calls for further study and substantiation.

THE BRAIN AND SPINAL CORD

Genesis of Cerebellar Functions. By Tilney (Frederick)—*Arch. Neurol. & Psychiatry*, Feb. 1923, IX, 137–169.

As a result of his studies the author has reached the conclusion that "phylogenetically the cerebellum represents an integrative process of specialization. This process, as the result of increasing motor capacity during the progress of evolution, has centralized in one organ certain specialized structures acquired from time to time as need has been. The principal purpose of this mechanism has been the maintenance of posture in all the varied types of motor activity. The cerebellar components which have developed during the several epochs of phylogeny and which have become more or less completely integrated within the ultimate cerebellum are: 1) the cerebellum bulbare and the cerebellum jugale, representing the archeparencephalon; 2) the cerebellum mediale, representing the paleoparencephalon; and 3) the cerebellum laterale, representing the neoparencephalon."

"L'indice de valeur cèrèbrale" au cours de l'évolution individuelle. By Anthony (R.) and F. Coupin—*Rev. anthropolog.*, 1925, XXXV, 145–151 (Preliminary note).

The index of cerebral value advocated by the author and based on the relations of brain weight to body weight at different periods of life, permits in his opinion of a better illustration of conditions and more satisfactory reading of conclusions than other methods. Applied to human ontogeny the results are of considerable interest.

Sulla morfologia dei solchi cerebrali dell'uomo, con osservazioni su cervelli d'indigeni del Camerun. By Genna (Giuseppe)—*Riv. Antrop.*, XXVI, 1924, 157 pp., 7 pl.

The author, after a detailed discussion of the different brain fissures, gives his observations on 11 hemispheres (of six individuals) of the Camerun negroes, collected by Haberer and preserved in the Anthropological Institute of Rome. Due to the limited number of specimens

and to scarcity of ample comparative data, he is unable to establish definite racial differences; but contributes notes of value on the morphology of various sulci. Good illustrations and a large bibliography contribute to the value of the memoir.

Chimpanzee Intelligence and its Vocal Expression. By Yerkes (Robert M.) and Blanche W. Learned—Baltimore, 1925 (The Williams and Wilkins Co., $3.50.)

The comparative study of the great apes, while necessarily the study of the psychologist, is of great interest to anthropology. Physically, the chimpanzee of all the known primates stands about the nearest to man, which justifies a strong desire to know how he compares in mentality. The small book at hand does not pretend to answer the question. The study of the mind in man, and still more in the ape, is beset with great difficulties and much work will yet be required before both be well understood. But the present report shows how it is possible to approach the subject in the ape scientifically and what may be expected from such study.

The items dealt with are: Provision for Comparative Study of the Primates; History and Care of a Pair of Chimpanzees; Physical Traits; Mental Traits; Evidences of Insight; Sounds and Speech; List of Words or Elements of Speech.

The physical description and measurements supplementing the study are also of value. It is hoped that in all lines the work may be duly extended.

I gruppi cellulari miorabdotici. Nota i. Nella regione cervicale del midollo spinale della Cimpanzè; Nota ii. Nella regione toracica ed i limiti tra regione toracica e regione lombare nel middolo spinale dello Cimpanzè; Nota iii. Della regione lombo-sacrale del midollo spinale dello Cimpanzè. By Sergi (Sergio)—*Rc. R. Accad. Naz. Linc.*, 1924, XXXIII, ser. 5^a, 2nd sem., fasc. 9, 10 and 11 resp.

Three important preliminary notes on the author's comparative studies of the spinal cord in man and one adult chimpanzee. He finds both noteworthy resemblances as well as differences in the relative development of the motor cells of the different segments of the cord.

The notes have the common disadvantage of preliminary communications. They do not satisfy the questions aroused by the brief statements. Also one wishes that these studies may be extended so as to give us something on the normal variation, individual, sex, age and group variation of the features studied, both in man and the ape. But this is probably too much to demand for the present.

BLOOD

Blood Types. Two young physicians in the Dutch colonies (at Deli, coast of Sumatra) have continued the interesting studies of von Dungeren and Hirschfeld, Verzar and other investigators on the signification of the agglutinating power of blood for anthropological researches. Dr. Bais and Dr. Verhoeff, namely, had the opportunity to

determine the biochemical blood index of 546 persons from Sumatra (natives of the island), 1346 from Java and 592 Chinese from South China. Those from Java and China were workers in the Deli tobacco cultures. In their interesting record of the known facts (*Nederl. Tydskrift voor Geneeskunde*, 1924, II, 1212) they reprint a graph of Hirschfeld with a supplement based on their own and other researches. This graph gives a survey of the remarkable facts, that the biochemical index related to the agglutinating power of the blood—has a maximum in West Europe (71) diminished in South-east direction till the minimum (41) is reached in British India. Farther eastwards in the direction of China there follows a rise again as indicated by the investigations of the authors. A small number (75) persons of British India investigated in the Dutch colonies, gave again the same low index as found by Hirschfeld in the inhabitants of the former country. A place apart is taken in this graph by the American Indians who have a very high biochemical blood index, but a low value as to the percentage belonging to group II and III of the four blood groups in which mankind has been divided. The biochemical index seems to be an inherited trait which follows the Mendelian law, as has been confirmed by the authors. Researches on a larger scale will have a great value for anthropology.

M. A. Herwerden
(*Eugenics Rev.*, 1925, XVII, No. 1, 48)

(Utilization of Serological Methods in Anthropometry. In Czech.) By Suk (V.)—*Anthropologie* (Prague), 1925, III, No. 2, 119–123.

A very good informative article, outlining briefly the meaning and uses of serology and their prospective value to anthropology. Most recent studies in this line indicate that the various agglutinins and precipitins, and hence the exact chemistry of the colloids and albumins, differ not only in human (as well as other biological) groups but vary also considerably in individuals and that the collective or groups differences are manifested by even the bacteria. It may soon be possible to talk of serological or biochemical, as we now talk of morphological, types of men. Serology opens a whole new field of research to the anthropological, medical and biological sciences, and will doubtless enrich greatly our understanding.

Serological Studies on the Blood of the Primates: I. the differentiation of human and anthropoid bloods. II. the blood groups in anthropoid apes. III. distribution of serological factors related to human isoagglutinogens in the blood of lower monkeys. By Landsteiner (K.) and C. Philip Miller, Jr.—*J. Exper. Med.*, 1925, XLII, No. 6.

"While the precipitin tests do not differentiate, according to the results of previous workers, between the serum proteins of man and chimpanzee, a clear-cut differentiation between the blood cells of man and the anthropoids was obtained by means of hemagglutinins. According to our tests on bloods of whites and negroes, constant racial

serological differences among human bloods, if they exist at all, are certainly smaller than the differences between the bloods of man and the anthropoid apes. The serological differences between man and the lower monkeys appear to be no greater than those between the anthropoid apes and the lower monkeys. These findings confirm the opinion that the anthropoid apes do not rank in the genealogical tree between lower monkeys and man.

"The bloods of twenty-one anthropoid apes have been examined serologically. It was found possible to assign each to one of the four human blood groups. The isoagglutinogens of the anthropoids were found to be identical with those of human blood. These very same factors could not be demonstrated in the blood of the lower monkeys. In the blood of the fourteen chimpanzees examined only the isoagglutinogen A has been found, whereas both A and B were present in the blood of the six orangs. The significance of these findings for the knowledge of the human blood groups is discussed.

"Serological studies on the bloods of thirty-six species of lower monkeys have shown that there exists a correspondence between the distribution of a certain hemagglutinogen and the place of the species in the zoological system.

"In twelve species of seven genera of Platyrrhina (New World monkeys) and six species of the genus *Lemur* a factor similar to the human isoagglutinogen B was present; in eighteen species of four genera of Cercopithecidae (Old World monkeys) it was absent, although the latter are more closely related to man than the former. It would seem from our findings that a genus, perhaps even a family, of animals may be characterized by a special serological factor. The factor found in the lower monkey is not identical with the one existing in the erythrocytes of the anthropoid apes and man."

HAIR

A Comparative Racial Study of the Structural Elements of Human Head-Hair. By Hausman (Leon Augustus)—*Am. Naturalist*, LIX, Nov.–Dec., 1925, 529–538.

"The cuticular scales and medullas of the human head-hairs are related, as are the same elements in the hairs of the *infra-hominid* mammals, to the diameters of the hair-shafts. They cannot be considered primarily, as characteristic of race. Human hairs have not been found to show any but one type of scale, *i. e.* the flattened, nor any but the continuous and the varieties of the fragmentary medullas. Neither the scales nor the medullas of human head-hair show any of those characteristic modifications of form which have been interpreted as being specific, or group, differences among the hairs of the *infra-hominid* mammals. It is believed not to be possible to identify individuals from samples of their hair, basing identification upon histological similarities in the structure of the scales and medullas, since these may differ in hairs from the same head, or in different parts of the same hair. 'Accidental' or unusually striking similarities can not, of course, fall within this category.

"The gross qualities of human head-hair *en masse*, seem to be much more accurately characteristic of ethnological groups of mankind (or at least more definitely usable) than do the microscopic units of the individual hair-shafts."

On the Hair Slope in the Frontal Region of Man. By Bolk (L.)—*J. Anat.*, April 1924, LVIII, Part 3, 206–221.

"The material employed for this investigation consisted of foetuses chiefly from Dutch mothers, only eight being derived from the population of Java . . . The study of the hair streams on the human forehead does not lead to the results one would have expected. The variability in the structure of the hair pattern is so great in this region of the skin that one scarcely comes across two individuals who are entirely the image one of the other. Now one would expect that a study of this excessive variability would lead to a solution of the causes determining the hair slope, but this is in no wise the case. The only conclusion which could perhaps with some justice be drawn from a comparison of the different conditions, is that the hair slope is not determined by external influences, but that it is probably the expression of certain conditions of growth in the skin. We are still, however, entirely in the dark as to the actual connection between the process of skin-growth and the hair slope."

Sur le changement de la chevelure chez les enfants des Mélanésiens et des Nègres Africains. By Sarasin (Fritz)—L'Anthropologie, 1925, XXXV, 467–474.

The author found that infants up to 1½ years of age of the black and woolly-haired New-Caledonians have hair that is nearly straight or but moderately wavy, and ranges from brown to light brown, and even lighter, in color. From two to five years, occasionally earlier or later, the hair, still brown, becomes strongly wavy to curly, occasionally already more or less frizzly. Above six years the children already present almost without exception the woolly hair of the adults, though occasionally it is still slightly less black. The infantile hair, brown, fine, near straight or wavy and cylindrical, has gradually become black, stout, woolly and flattened. Similar phenomena have been reported from the New Hebrides among African negroes. Curliness of hair is therefore a secondary character and cannot be utilized as a base of classification of the human races.

The reviewer wishes in this connection to call attention to somewhat similar conditions among the Australians (see this Journal, IX, No. 1); and especially to the occasional occurrence, witnessed by him personally in a series of cases, of tow-haired children, adolescents and even adults, among full-blooded Australians of the western and southern portions of Australia. These individuals are otherwise full-colored (brown to black) and are not mixed-bloods with whites.

MISCELLANEOUS

Four Generations of Polymastia. By Klinkerfuss (George H.) —*J. Amer. Medical Ass.*, 1924, LXXXII, 1247–'8.

The author's conclusions are: "In some families, polymastia is hereditary. These tumors of the axilla, enlarging in pregnancy and keeping pace with the rapid enlargement and engorgement of the breasts in the early puerperium, should be classed as polymastia. Apparently the masses without nipples have some connection with the normal breasts, possibly by an elongated duct. These accumulation of breast tissue should not be confused with inflammatory processes; and the patient should be assured that they have nothing in common with carcinoma of the breast."

Pigmentation physiologique de la muqueuse buccale en France. By Rouzaud (—)—*Semaine dent.*, VII, No. 26, June 28, 1925, 665–668.

Pigmentation of the mucous membrane of the mouth in whites has for a long time been considered as a special manifestation of Addison's disease. To-day it is clear that the phenomenon may develop in the course of varied pathological conditions; and it may even be observed in subjects who show no signs of disease, when it is called "cryptogenetic pigmentation." There are in fact cases of physiological pigmentation of this nature unconnected with any pathological condition. These cases are frequent in some races (of whites) and rare in others, but seem to occur in all. The phenomenon may particularly be observed in the French. Its cause has been supposed to be some previous admixture, but more probably it is a simple reversive anomaly. Among 970 subjects examined for the condition the author found the "hyperchromy" in 24. It appears in the form of dark, brownish or bluish patches. These develop especially about puberty, rising in frequency up to old age. They are much more frequent in males than in females and in dark than in light subjects.

Sillons et rides de la langue. By Dubreuil-Chambardel (Louis)—*Semaine dent.*, Jan. 13, 1924, 34–40. (Also Prog. Méd., 1923, No. 51).

The author distinguishes congenital tongue furrows and those developing later, particularly after the 40th year. The former are well marked, symmetric, with definite locations, especially towards the borders of the tongue; the latter, which may also be called "physiological," develop especially over the middle part of the dorsal surface, are shallow and multiply with age. Both exist apart from furrows due to pathological conditions.

Über Handlinien. By Pöch (Hella)—*Mitt. Anthrop. Ges. Wien*, 1925, LV, 133–159.

The writer studied the palmar lines on 66 embryos, numerous children and adults, and especially in families. The main lines are given and recorded by numbers. They begin to develop early in embryonal life and soon show individual variation. It seems that they are influenced by the length of the metacarpals and the line of the primal joints of the fingers. The separate lines appear to be individually hereditary; the extent and mode of inheritance, however, differ so that they are more valuable for personal identification than as documents of definite heredity.

Palm and Sole Studies, VIII: The Occurrence of Primitive Patterns (Whorls). By Wilder (H. H.)—*Biol. Bull.*, Sept. 1925.

The paper presents the cases of primitive patterns of the Whorl Type found to occur in human beings, and found in the author's collection of the hand and foot prints of approximately 1800 individuals, and embracing many different human races, and including both sexes. Nearly every one of the twenty-three patterns is found to occur, and the occurrence has no special connection with either race or condition, as these primitive patterns are quite as likely to occur among the most educated and cultivated people as among the proletariat, and among the European-Americans, as among those peoples that are usually considered lower and more primitive. Certain of these patterns, like the second interdigital of the hand, are found rarely, and the calcar of the foot, a rare pattern in any shape occurs but once in form of a complete whorl, but that was found of one foot of a university professor, and a biologist at that! Of the two patterns of the hand, associated with the thenar eminence, each was found but once, but while one of these was on the hand of an American banker, the other occurred on a native Liberian soldier. As the paper consists largely of the actual illustrations taken from prints, these illustrations furnish their own conclusions.

H. H. W.

The Nature and Inheritance of Webbed Toes in Man. By Straus (Willliam L.)—*J. Morph. & Physiol.*, 1926, XLI, No. 2.

"Webbing of toes or fingers in man is produced by a local arrest of development, causing retention of the normal embryonic webbing. This type of digital fusion involves only the skin, the skeleton being unaffected. The extensor tendons of the toes may sometimes be fused.

"Webbed digits occur normally in some marsupials, rodents and insectivores, in a number of lemurs and catarrhines and in some siamang and gorilla. They also may occur in varying degree in other Primates, notably Hylobates. An analysis of four new pedigrees together with those already published demonstrates that webbing of toes in man may be inherited in either a mendelian or sex-linked manner. In one case this character follows the course of the Y-chromosome."

(Growth of the Heart and the Aorta. In Czech. Abstract in French). By Borovansky (Ladislav)—*Anthropologie*, (Prague), 1925, III, No. 3, 188–200.

The author reviews previous work in this direction, adds a large series of his own observations and reaches the following conclusions:

The size of the heart as a whole differs considerably in individuals of the same age. In the course of growth, the capacity of the cavities of the heart augments much more readily than the cardiac muscle; but there is no appreciable difference between the growth of the cardiac muscle and that of the lumen of the aorta. Increase in the size of the heart is therefore due more to the enlargement of its cavities than to that of its muscles.

"Between the end of the first year of life and the attainment of full growth, the calibre of the aorta augments four and a half times . . . capacity of the left heart cavities approximately twenty times."

Contribuicao para o estudo das anomalias arteriais no vivo. By de Sousa (Alberto)—*Trab. Soc. Portug. Antropol. & Etnol.*, 1925, II, Fasc. III, 239–248.

The author reports thirteen cases of arterial anomalies in the living, observed in the Anatomical Institute of the Medical School in Porto. Ten of the cases were in the right radial, one in the left radial and two in the cubital artery. These cases are not only of morphological but also of clinical interest.

The Facialis Musculature of the Orang, Simia satyrus. By Sullivan (Walter E.) and Carroll W. Osgood—*Anat. Rec.*, 1925, XXIX, No. 3, 195–243.

A valuable contribution to our knowledge of the facial musculature of the orang as well as other anthropoids. Summary: The facial muscles of the anthropoids are complex and especially so in the oral and interorbital regions. We have not had enough material to warrant much generalization, but a few points seem well enough established to warrant our mentioning them here. Some of the more interesting features have been mentioned in the introduction. The platysma of the orang has retained more of its nuchal and deltoid portions than that of either the chimpanzee or gorilla. In addition it has a direct attachment to the acromion. The musculus quadratus labii inferioris is essentially the same in all three animals. The epicranial musculature of the orang is in two layers in the occipital region. The epicranial fascia is also in two layers. This condition is not described for the chimpanzee and gorilla. The orbito-auricular muscle of the orang has a very definite attachment to the frontal bone; in the chimpanzee the attachment to the bone is weak or absent; in the gorilla the attachment in front is in part to bone, in part to fascia. While there is an occasional conflicting statement it appears that the epicranial region of the chimpanzee has more fibrous and less muscle tissue than that of the orang and gorilla. The extrinsic muscles of the ear are found in varying degrees of independence. The orbicular muscle of the eye of the orang has its marginal bundles attached to the lateral orbital wall through a strong tendon. This condition has not been described for the chimpanzee and gorilla. A muscle of Horner was not definitely isolated but this may have been due to faulty technique. No well-marked lateral palpebral raphé has been found in the orang or gorilla; one has been described for the chimpanzee. The musculus corrugator supercilii is absent from the orang, present in the chimpanzee and represented weakly in the gorilla. The musculi depressor supercilii and procerus are present in all three animals. In the orang the procerus is not readily separable from the musculus levator labii alaeque nasi. In general it should be said that the condition in the interorbital and dorsal nasal regions is complex and there is abundant opportunity for different interpretations of structures that are quite similar. The musculature of the lips of the orang is intricate. During life this is correlated with a very high degree of mobility. The zygomatic muscle is absent from the orang; that of the chimpanzee has been described as having deep bundles of insertion while that of the

gorilla has not. The musculi orbito-labialis et orbito-malaris have no attachment to bone with the exception of a few deep bundles of the orang. In the chimpanzee and gorilla they occupy the space between the zygomatic muscle and the orbicular muscle of the eye; in the orang they are adjacent to the orbicular muscle. The maxillo-labial muscle is very much the same in all three animals although that of the orang seems to have the most extensive origin. The triangular muscle is best developed in the orang. Here we find a direct attachment to the mandible. In the chimpanzee it has been described as very weak and thin; in the gorilla it attains no great degree of independence of the canine. The canine muscle is also best developed in the orang. The buccinator muscle is very complex in all three animals, but the attachments are essentially the same. . . The most striking thing in the lips of the orang was the paucity of truly orbicular fibers . . . the exact condition in the lips of the anthropoids is far from being clearly demonstrated.

(The Transverse Nuchal and Transverse Chin Muscles in a Chimpanzee; In Polish, English Abstract). By Rózycki (Stefan)—*Kosmos*, 1924, XLIX, 33–40.

"*M. transversus nuchae* was described in the chimpanzee till now only by Macalister (1871, 341).

Author found this muscle pretty well developed in one young female chimpanzee. The muscle in question was placed backward from the concha of the left ear and was composed of two parts, which had together the shape of the letter y. One part commenced with two slips from *linea nuchae superior* and from fascia of the *m. splenius capitis* and ended in parotid fascia not far from the upper margin of the *m. platysma myoides*. The other part of the muscle was lying across the *m. auricularis posterior* and extended from its upper margin, where it was blended with the *pars auricularis musculi auriculo-occipitalis*, till above the first part of the muscle, with which it was connected by a short and slender fibrous slip. *M. transversus menti* was described for the chimpanzee by Gratiolet and Alix (1866, 211) and for the gorilla by Deniker (1886, 114–'5). Ruge (1887[a]. 102, 7) and Blüntschli (1909, 234) called it the progressive, exclusively human muscle. I found this muscle well developed in the same young female chimpanzee, which had the *m. transversus nuchae*. It was represented by a very thin muscular slip, 0.7 mm. wide, which crossed the *m. platysma* beneath the chin and connected the triangular muscles (*m. triangularis labii inferioris*). Its length between the under margins of the mandible was 28 mm.

In a young male chimpanzee, though the *m. transversus menti* was absent, both the triangular muscles were well developed and the muscular slips reached down behind the under margins of the mandible. The ends were separated by an interval of 21 mm. which was filled with fascia, covering the *m. platysma*.

Author believes that the two muscles in question would have perhaps been found more frequently in Primates if anatomists had always received their material with the skin undamaged. The presence of these two muscles in the chimpanzee is not without significance for the morphology

of the muscles. It tends to decrease the number of certain primitive forms, which are to be found more often in man than in anthropoid apes (*m. transversus nuchae*). On the other hand it shows, that *m. transversus menti* is not the exclusive attribute of mankind."

VARIATION: SKELETAL

THE VERTEBRATE SKELETON FROM THE DEVELOPMENTAL STANDPOINT. By Kingsley (J. S.)—8°, Phila., 1925, 373 pp., 324 illustr's (P. Blakiston's Sons & Co.).

"This volume aims to give an outline of Vertebrate osteology, tracing the skeletal elements from their early appearance to the adult condition . . . Since knowledge of the adult structures of higher vertebrates is best obtained by comparisons with lower forms, greater stress has been laid on Ichthyopsida and on reptiles than upon birds and mammals, which have been more adequately treated elsewhere than have lower groups. There is also reference to extinct forms as these frequently throw light upon the living species. The work is intentionally descriptive, and no attempts have been made to trace lines of descent, although here and there hints are given of the relations of groups. While teeth are really parts of the skeleton, they are largley ignored here, because of inadequate knowledge on the part of the author and from lack of space." Appended is a bibliography of nearly 1,000 books and papers, and there is a good index. The illustrations and the paper and binding of the book leave little to be desired.

Over one-half of the text is given to the skull. The treatment of the subject is orthodox—it is the rounded-up presentation of facts for the regular student, more than for the man of research. And from the standpoint of physical anthropology, the main things—a thorough treatment of the comparative anatomy of the skull, skeleton and teeth of the primate phylum and of skeletal and skull variation within the species—are missing or very inadequate. Here is a field that needs greatly to be covered.

OSSEOUS DEVELOPMENT IN ENDOCRINE DISORDERS. By Engelbach (William) and Alphonse McMahon—*Internat. J. Orthdontia*, 1925, XI, No. 2, 124–163 (see also *Endocrinology*, 1924, VIII, 1–53).

"The general diagnostic information derived from the roentgenologic comparison of endocrinopathic and normal subjects has led the writers to believe that the radiologic signs offer encouraging prospects of being of more value than the basal metabolism, blood chemistry and other so-called specific and laboratory determinations. Retardation of development of all the bones of the osseous system, not only of the carpals, in uncomplicated hypothyroidism can be demonstrated roentgenologically in all ages up to that of completion of normal skeletal growth. This will be an additional aid to diagnosis in those cases already beyond the age of normal carpal development upon which basis hitherto has depended the roentgen picture of osseous change indicative of hypothyroidism. Hypogonadism and eunuchoidism have consistently shown a definite late fusion of the epiphyseal ends of the long bones. While this has been

suspected clinically, we are unacquainted with any definite roentgenologic demonstration of these abnormalities in secondary hypogonadism. The late closure of the epiphyseal ends in the presence of an active hormone from the anterior lobe of the hypophysis explains the *overgrowth of the long bones* in these subjects. In anterior lobe pituitary insufficiency in which there is a primary deficiency of the anterior lobe and a secondary deficiency of the generative organs, there has been found uniformly present a late closure of the epiphyseal ends of the long bones, *associated with undergrowth* of these bones. The reason for the undergrowth of the long bones in the presence of the open epiphyseal ends in this disorder is the *absence of the hormone from the anterior lobe of the hypophysis.* In the pluriglandular syndrome, the development of the osseous system as demonstrated roentgenologically is very difficult to interpret. From the studies of our cases thus far we are of the impression that the following facts obtain: 1) In the thyro-pituitary disorder there is an advance of the carpal and long bone nuclei development over that of pure hypothyroidism unassociated with pituitary disorder. 2) In pituitary-thyroidism, there is a retardation of the appearance of the osseous nuclei, as well as of the fusion of the epiphyseal ends of the long bones, more marked than that in pure hypothyroidism or in the normal. 3) The markedly heterogeneous pictures presented in the multiglandular syndromes will depend upon the sequence in which the various disorders were superimposed upon each other. For this reason, the combination of the same glandular disorders might present entirely different radiographic pictures of the osseous development at the same age, depending upon the order in which the various glands might have become involved.

"In the less frequent but very instructive condition of pubertas praecox (suspected pinealism), the most unusual advancement in development of the bone nuclei and early fusion of the epiphyseal lines was found. The four cases studied confirmed our earlier belief relative to the effect of gonad hormone upon the osseous growth and development, and were a convincing confirmation of the exactly opposite picture consistently present in the hypogonad. Thymo-lymphatism in the few cases studied apparently presented much the same osseous retardation as mild hypothyroidism. The osseous development in positive cases of enlarged thymus should be more thoroughly studied, with the view of clearing up this much mooted point of the relation of thymus function to osseous development."

Asymmetry in the Skulls of Mammals. By Howell (A. Brazier)—*Proc. U. S. Nat. Mus.*, No. 2599, LXVII, 1925, Art. 27, 1–18.

From a study of four interesting asymmetric mammalian crania (a gorilla, a Lasiopyga monkey and two skulls of Pinnipeds) the author concludes that, "the primary cause inducing asymmetry in the skulls of mammals other than toothed cetaceans is probably, in most instances, by accident or disease, to the bones or muscles of a single side of the head at a comparatively early age, and that this must be of such a character as to result in a stunted or infantile condition of a crucial part of the bony framework, and a reduction in the rate of growth or strength

through lesions, of the muscles of a single side. Asymmetry usually is directly dependent upon uneveness in the strains developed upon the two sides of the head while an animal is eating.

"Certain injury to the bones of the head causes a premature obliteration of the sutures as already indicated. Published data respecting human crania have shown that such early obliteration of the sutures may also occur from obscure causes without violence having been suffered by the individual. It is doubtless fortuitous that no skulls of this character have been available in the present study. Conversely, it is known that retarded obliteration of certain sutures beyond the usual time for their disappearance results in the hypertrophy of the corresponding part of the skull. It is only a question of time before material illustrating the latter point in the mammalia other than man is brought to light.

"One of the most conspicuous results of this investigation and one that deserves to be stressed, is the conclusion that normal development of the bones of the skull is directly dependent upon the growth of the attached muscles. In other words, if for any reason the muscles of an animal remain infantile and fail properly to grow, the bones to which they are secured will remain proportionately undersized. This assertion can not be proven in the case of the masseter muscles until the myology of asymmetrical skulls can be more fully investigated. It is also apparent that the smaller the origin or fossa of a muscle the smaller must the muscle itself be. The significance of these facts, when considered with reference to specific (and higher) variation of the skull, is profound.

"It is apparent that asymmetrical development of a skull inclines to progress both forward and backward from a center that is rather uniform. In other words, it always appears as though a part of the skull were held stationary while the portions craniad and caudad were both forced either to the right or to the left. This center is not precisely the anterior one of the three segments of the cranium proper, as has been claimed, but the "dead center" may be considered as passing through the frontals above and palatals below. Either of these pairs of bones may vary somewhat in accordance with the portion of the skull either craniad or caudad thereto, according to whether the more powerful influence lies in one direction or the other. In the four skulls examined the original seat of injury has been in the neighborhood of one of the glenoid fossae.

"It is difficult, if not impossible, to speculate with any degree of certainty upon the relative development of the temporals and masseters, considered as separate muscles, because of their extreme interdependence. The previous condition of the masseters can only be deduced from the configuration of the zygomatic arch. Reduction in the size of one temporal muscle is not necessarily followed by a smaller zygomatic arch, and therefore by inference a smaller masseter upon that side; but reduction, for any reason, of the size of the arch, does seem to result in a lessened volume of the adjacent temporal muscle.

"The interrelationship of the anterior with the posterior portion of the temporal muscle is somewhat obscure, but fluctuations in the size of this muscle are not necessarily uniform for the two parts. The size

of the anterior portion of the temporal fossa—lying immediately adjacent to the supraorbital processes in carnivores—may be very much larger, indeed, upon one side when the posterior portion—overlying the brain-case proper—is but a trifle more extensive than upon the opposite side. The explanation of this fact is believed to be that the extreme cranial portion of the temporal muscle is the part that is used in contributing the ultimate contracting power of which the jaw muscles are capable. As this final force can hardly be applied upon the weaker side of the head because of pain or mechanical disability, nondevelopment of the anterior part of the temporal muscle upon that side of the cranium results. Certain it is that a disparity in the development of the anterior, as compared with the posterior, part of an abnormal temporal fossa recurs sufficiently often to indicate a substantial difference in the precise functions of the two corresponding portions of the temporal muscle.

"The pterygoid plates and fossae naturally reflect the development of the pterygoid muscles, and a smaller plate upon one side means that the muscles attached thereto were correspondingly weaker."

(The Inclination of the Orbital Apertures as a Plane for the Orientation of the Skull. In Czech, French abstract). By Maly (Jiří)—*Anthropologie*, 1924, II, Nos. 3–4, 224–230.

The author calls attention to the availability of the orbital aperture as an accessory plane for the standard orientation of the skull, and gives directions for its use.

The Cranio-Facial Axis of Huxley. By Cameron (John)—*Proc. Roy. Soc. Canada*, 1925, Sec. V, 129–136.

This is the second contribution of the author to the study of the development and racial variation of the cranio-facial axis, as measured by the "main angle of cranial flexion," formed by lines connecting the "pituitary point" (the salient point of the angle at the anterior edge of the pituitary fossa) with the nasion and the basion. The present data relate to 358 male with 51 female whites, and to 153 male with 37 female negro (American) skulls. The results show interesting racial as well as sex differences.

The Comparison of Auricular Height Determinations. By Todd (T. Wingate)—*J. Anat.*, 1925, LIX, Part 4, 390–'93.

"For practical purposes it is immaterial whether one use the bregma or the vertical point in measurements of auricular height, provided the sample taken be of significant size. The vertical point has the advantage that it bears a definite relation to the Frankfort plane. Since it is determined automatically by the employment of a suitable instrument it has an advantage over the bregma which, in the living, can be estimated only by anatomical appreciation. The average distance between the bregma and the vertical point in male White skulls is 11.7 mm., but the variability of this deviation indicates that the vertical point may be found anywhere from 10 mm. in front of the bregma to 30 mm. behind the bregma. In the great majority of crania it lies behind the bregma.

There may be a small divergence from time to time in the exact position of the vertex on dried skulls following minute adjustments in the cranio-facial skeleton."

(The Relative Positions of the Foramen Magnum, the Condyles and the Mastoids. In Czech, with good abstract in French). By Drozda (V.)—*Anthropologie* (Prague), 1925, III, No. 3, 201–212.

Interesting studies on 61 human and 5 ape skulls. Differences between human and ape skulls are considerable, those in the human material (of several races), even between the adults and infants, are relatively small. The detailed results and the measurements will be of value to students of the regions dealt with.

On the Anomalies of the Occipital Bone. By Hori (Taiji)—*Folia Anat. Japonica*, 1925, III, No. 6.

"Four hundred and ten skulls of Japanese from the province of Kanazawa were examined. Of these 365 were of adults and 45 of immature individuals. In addition to this material ten isolated occipital bones were studied. The author directed his attention especially to the anomalies of the occipital bone and the main results obtained were as follows: The canalis basilaris medianus occurs in nine cases (2.3 per cent); the fossula pharyngea occipitis in seven cases (1.8 per cent); the fossula vermiana in thirty-four cases (8.5 per cent); the torus occipitalis in seventy-five cases (18.5 per cent); the processus retromastoideus in one case (0.3 per cent); the os epactale in eight cases (2.0 per cent); the ossa suturarum in ninety-four cases (24.7 per cent); coalescence with the atlas in six cases (1.4 per cent); presence of the occipital vertebra in eighty-one cases (20 per cent); and persistence of the synchondrosis intra-occipitalis posterior in seventeen cases (5.4 per cent)."

(Capacity of Czech and old Slav Skulls. In Czech, with summary in French). By Mišička (C. Jan)—*Anthropologie*, 1924, II, Nos. 3–4, 211–223.

The author, after discussing methods, shows that skull capacity in Bohemia and Moravia has not suffered material modification from the X-XII to the XVIII centuries. It is hoped that the promising work may be extended to the great material offered by the Czechoslovak ossuaries.

A fronte nos Portugueses (estudo craniométrico). By Valença (Eduardo)—8°, 1925, Porto, 94 pp.

The memoir, one of a growing number of recent creditable contributions of Portuguese students to physical anthropology, deals with the results of the author's studies on the frontal bone in 75 male and 75 female crania, mainly from the northern parts of Portugal. As the dolichocephalic mediterraneans in general, the Portuguese are not exceptionally "frontalized." There are noteworthy sexual differences in the linear measurements, in the angle of the frontal convexity and in the "curve index;" the female frontal is absolutely narrower and more vertical as

well as convex than that of the male. The various characteristics of the frontal are seen to have only secondary diagnostic value, psychological or medical. All of which agrees closely with recent studies on the forehead in the living Americans (Hrdlička, The Old Americans, 8°, Waverley Press, Baltimore, 1925.) Appended to the memoir are the detailed measurements and a bibliography.

Cranios normales y deformados de los Andes: Peru y Bolivia. By Sainz (Luis de Hoyos)—*Actas y Mem. Soc. Españ. Antrop.* Madrid, Part I, Vol. II, 1923, No. 2, 151–184; Part II, Vol. III, 1924, Nos. 1 & 2, 2–38; Part III, Vol. III, No. 3, 185–230.

The author describes a series of deformed and a number of non-deformed crania (at least two of the latter, however, show slight occipital compression), from the elevated regions of Peru and Bolivia. Comparisons and deductions, regrettably, will only be the subject of a future contribution.

Nouveaux documents sur les variations du rachis. By Monteiro (Hernani B.) and L. Dubreuil-Chambardel—*Bull. & Mém. Soc. Anthrop. Par.*, 1924, V, Sér. VII, F. 1, 2, 3, pp. 3–19.

Reporting new cases the author deals with: The occipitalization of the atlas; numerical reduction of the cervical vertebrae; sacralization of the fifth lumbar; separation of a part of the neural arch of the fifth lumbar; and a congenital early fusion of the coccyx with the sacrum. All these anomalies are attended by definite clinical symptoms and a knowledge of these is of importance to the surgeon.

Modern British Pelves in the "Alfred Hughes" Museum of Anatomy, University College, Cardiff. By Hepburn (David)—*J. Anat.*, April 1925, LIX, Part 3, 328–330.

The essentials of the measurements of 52 modern British pelves and several pelves of anthropoid apes. The pelvic or brim index in the human specimens ranged from 62 to 99.1 in the males; 62.2 to 85.4 in the females.

La courbure du fémur. By Fraipont (Charles)—*Rev. anthropol.*, 1925, 329–340.

In the quadrupeds the curvature of the femur has no relation to the inclination of this bone with the tibia. In the upright posture, on the other hand, the smaller the angle the femur forms with the tibia the more marked is the curvature of its shaft; but when the posture is fully erect the femur again straightens.

In connection with these studies the author presents certain thoughts on the human phylum and on the phylogenic significance of some of the remains of early man.

Über die Beziehungen der tibialen Gelenkfläche des Femur zur Schaft Krümmung. By Ried (H. A.)—*Anthrop. Anz.*, Jhrg. II, H. 2, Stuttgart, 1925, 113–128.

A painstaking study of the articular convexities of the condyles of the femur, and of their relation to the torsion of the shaft resulting in many details of interest. In general the stronger the torsion of the shaft, the stronger is also that of the condyles. Good illustrations with a number of tables facilitate much the reading of the article.

THE EPIPHYSES OF THE BONES OF THE EXTREMITIES AT PUBERTY. By Sullivan (W. H.) and F. D. Geist—*J. Bone & Joint Surg.*, April, 1924.

In classifying epiphyses the authors have followed Parsons' grouping into pressure, traction and atavistic not because it is of fundamental worth, but because it permits orderly comparisons and discussion necessary to a proper analysis of the problem. Why there are epiphyses is still an open question. There are only two suggestions to make. First, hyaline cartilage is primarily an "embryonic" tissue both in phylogenesis and in autogenesis and cannot maintain itself over a long period without ossification or at least calcification. Epiphyses are especially well marked in vertebrates with a long period of growth but few in kinds which have a short period. Second, all epiphyses represent structures that were at one time independent skeletal elements. Atavistic epiphyses and the relation of traction epiphyses to sesamoid bones give support to this theory.

The relation of the epiphyses to the joints is described and pictured. Obviously, where the range of movement is wide the epiphyses will tend to be intracapsular; where the range is limited, extracapsular, but this generalization is not of much value.

A COMPARISON OF THE EVOLUTION OF CARPAL CENTERS IN WHITE AND NEGRO NEW-BORN INFANTS. By Hess (Alfred F.) and Mildred Weinstock—*Am. J. Dis. of Children*, March 1925, XXIX, 346–354.

"It is by no means uncommon to observe by means of roentgenograms the presence of carpal centers in infants at the time of birth. This development was noted more frequently in female than in male infants, and was somewhat more frequent in heavier than in lighter babies. Quite apart from the factors of sex or of weight, new born negro infants, both male and female, showed calcification of the centers far more frequently than white infants. This is interpreted to be due to a racial difference. The question whether this distinction in development and maturity bears a relationship to the well-known susceptibility of the negro to rickets is raised but cannot definitely be answered."

TEETH

THE EVOLUTION OF MAN'S TEETH FOUNDED UPON A STUDY OF THE DEVELOPMENT OF THE AUSTRALIAN ABORIGINAL. By Smith (W. Ramsay)—*J. Anat. & Physiol.*, XLII, 126–131.

The author's conclusions are as follows: The facts "show that cuspidate teeth, like canines and incisors, are developed from a simple tube of dentine tipped or topped by enamel. They show also that this development takes place by constriction. What is the explanation of the tubular form which the specimens present? Is this tube the original

cone from which such teeth are supposed to be developed? If not, does it represent a stage in evolution later than the supposed stage of fusion of several cones? Surely, it were a work of supererogation for two, three or four primitive cones either in the individual or the race, to go through a stage of fusion, then by absorption of their adjacent septa to become hollowed out into a single simple cylinder or cone or tube such as is presented by these specimens, only to become finally reconstricted to form milk molars, bicuspids or molars as the case may be. It seems to me that there neither is nor has been any such fusion or absorption, but that the complicated milk molars, premolars and molars are formed by plication or constriction of aboriginal primitive single simple cone or tube according to the method demonstrated by these specimens.

"It is not too much to claim that the whole theory of the origin of 'heterodont' teeth from fused primitive cones, as well as the theory of the aggregation of cusps in so far as it involves the origin of roots, will have to be reconsidered in the light of these and similar specimens from Australian aboriginal subjects. Further some exceptional abnormalities of fusion of teeth may best be explained in accordance with this mode of development from one primal tube."

DENTITION AND PALATE OF THE AUSTRALIAN ABORIGINAL. By Campbell (T. D.)—*Publ. Keith Sheridan Foundation*, Univ. of Adelaide, 1925, No. 1, 123 pp., 53 pl's.

In this very creditable, painstaking report on the large cranial collections of the South Australian Museum and the Department of Anatomy of the University at Adelaide the author shows that "a detailed study of the teeth and adjacent structures over a large series of skulls, is not only one of importance from the aspects of Physical Anthropology and Pure Dental Science, but it also provides data and lessons of no mean value for the problems of Applied Dental Science." His conclusions follow: "The jaws and teeth of the Australian aboriginal are strikingly well formed, with a capacious palate, well-shaped arches and large teeth; all of which depict a thoroughly functioning and efficient masticatory system. The teeth of the Australian in size are probably larger than those of any other living race; and in comparison with those of extinct races are sometimes larger, and in most dimensions equal in size. The teeth in crown form, cusp number and root form are exceedingly primitive, probably more so than in any other living race, and also than in some extinct races, such as Tasmanian and Neanderthal man. The arches are well formed and the type contours show in the adult that parallel figure which is considered the most primitive outline. The palate is highly arched and capacious, and so far as available comparative results show, is probably larger than that of any living race; larger than the recently extinct Tasmanian and the Bronze Age dweller of Great Britain; but in its type form not so large as some of the Pleistocene men such as those of Heidelberg and Piltdown. It does not possess the somewhat circular form attributed to Neanderthal man, but presents the more primitive contour. The symmetrical occlusal and interproximal wear of the teeth, and the glenoid fossae depths, indicate that the

Australian probably effected mastication by regularly alternating lateral excursions of the mandible. The vitality of the pulp and periodontal membrane was apparently very vigorous, as has been shown in the case of the pulp by the remarkable manner in which it physiologically resisted encroachment on its cavity by secondary deposit; and in the case of the membrane by the marked functional stresses it withstood without showing evidence of frequent or general periodontal affections. The condition of the deciduous teeth would show that the children were remarkably free from dental diseases, that their teeth functioned actively directly they were acquired, and that such developments as eruption of the teeth, formation of the arches, and development of the palate, took place in a very regular manner. The Australian dentition was strikingly free from developmental aberrations and dental diseases. The latter, as represented by such universally occurring affections as caries, alveolar abscesses, and periodontal lesions, were conditions almost entirely limited to old age. The marked immunity from dental diseases would seem to be very closely related with the coarse tough food which formed their diet and the crude methods of preparation and cooking when such were utilized. The observations show in every aspect a very marked difference between the well-formed Australian dentition, and ill-formed, disease-stricken masticatory outfit with which most modern civilized people are burdened.

"Probably the chief benefit derived from such a study as has been here attempted, is the great lesson to be learned, namely, that if modern civilized races are to preserve strength and contour in the lower architecture of the face, to make the masticatory organs a physiologically functioning unit, to diminish the awful present-day ravages of dental diseases and their concomitant systematic disturbances, and through all these to assist in building up sounder and healthier conditions, then there will have to be some drastic changes in the present-day dietary and method of food preparation. In short, a return to food conditions much more primitive than those at preent in vogue will be necessary."

A Comparative Study of the Jaws and Occlusion of Maori and of British Born in New Zealand. By George (Violet)—*Intern. J. Orthod.*, 1926, XII, No. 1, 20–24.

In a nice study Miss George has examined 20 plaster casts of the dental arches of the Maori and 20 of the New Zealand-born English. The Maori arches she found to be larger, more regular, the teeth larger. sounder and in general more normal than those of the whites.

Déviations congénitales de développement. By Boissier (Raymond)—*Sem. dent.*, 1924, VI, No. 45, 1161–'65.

In this brief but substantial article the author deals with, 1) The congenital deviations of the development of the teeth and jaws; and 2) Acquired conditions, which in turn may be due to general, local causation. With the former, however, he fails to consider the important evolutionary causes, and adaptation with the latter.

Some Changes in the Human Face as Influenced by the Teeth. By Hellman (Milo)—*Natural Hist.*, 1926, XXVI, No. 1, 68–74.

"There are few parts in the make-up of the individual that portray so well the effect of development as does the face. From the beginning to the end of life the face undergoes a continuous series of changes. The graduations of these changes are, to be sure, imperceptible, and definite border lines do not exist; but certain stages, once reached, become well defined and are easily recognized." The teeth constitute an important factor in this process. The facts may be summarized as follows: "The growing face continues increasing in height from infancy to old age and the greatest increase occurs at the time when the adult stage is reached. There is, however, also a decrease to be noticed. But that occurs in senility. The dentition, too, follows a certain course during its development. The dental height increases from the time the deciduous teeth begin to erupt in early infancy to the completion of the permanent dentition, lacking as yet the wisdom teeth (third molars). But as soon as full growth is attained (the third molars completing the permanent dentition) a decrease in the dental height begins. The relationship between (these two) phases brings an interesting fact into relief, i.e. it shows that the stage presenting the greatest increase in the dental height, precedes that of greatest increment in the growth of the face. This is very interesting for it demonstrates that even the adult reminds one of some phylogenetic (group development) facts concerned with the mouth and face. The mouth being the oldest part of the face, develops first; the face then grows around it."

A Study of the Jaw and Arch Development Considered with the Normal and Abnormal Skeleton. By Howard (Clinton C.)—*Internat. J. Orthodontia*, 1926, XII, No. 1, 1–14.

"Two years ago there was opened in Atlanta, Georgia, "The Good Samaritan Clinic" the object of which was the study and treatment of endocrine disorders. . .Regardless of whether the ductless glands are responsible for proper growth and development or whether dietetics is the principal influence in the scheme of bone progress, the fact remains that endocrinology has pointed the way to examine an individual and consider such discrepancies as improper hair growth and distribution, body proportions, bone progress, genital development etc., etc. Then by viewing such findings in an unbiased effort to correlate well-known mouth deformities with body anomalies, we have been rewarded by a comparative result that proves not only interesting but convincing. The next and greatest advancement in dentistry will result from our broader study of the influence of body growth and general tissue changes upon the normalcy of the total oral structures and associate parts." The results from the point of view of the student of human jaws and teeth are encouraging.

La saillie mentonnière en orthopédie dento-faciale pour le diagnostic et le traitement. By Izard (G.)—*Sem. dent.*, VII, No. 18, May 3, 1925, 456–461.

"Besides the usually described facial deformations there exist others, more or less pronounced, in the protrusion of the chin, through its excess (macrogeny), or defect (microgeny)."

The author deals briefly with the evolution of the chin, the theories of its causation and its variations; and with the practical indications of its anomalies to dentistry.

Food and Teeth. By Hellman (Milo)—*Dental Cosmos*, Feb. 1925, 185–195.

"What the effect of nutrition may be upon the lasting quality of the teeth is not known. An investigation of this question is the duty of the dentist. The dentist must yet be able to answer the question of what the average duration of man's teeth is or should be *i.e.* at what age is the adult supposed to lose a certain tooth or at what average age is he supposed to be normally toothless? A study of this sort may be correlated with the food habits and diseases of individuals who become toothless at an early age and those retaining their teeth to an extremely old age." The author's studies are not comprehensive enough to lead to definite conclusions, but his observations on root exposure and frequency of caries in different races are suggestive. Thus: "The Hindus, who subsist mainly on carbohydrates, show an excessive exposure of the root, the highest percent of carious teeth and next to the highest percent of malocclusion. The Australian aboriginals who are confronted with a scant and coarse food supply, show a similarly excessive root exposure, a lesser percent of carious cavities and an exceedingly low percent of malocclusion. The Eskimos, confined to a protein diet, show a still lower extent of root exposure, the lowest percent of tooth decay but the highest percent of malocclusion of the teeth. The American Indians, with a varied diet in considerable abundance, show the lowest extent of root exposure, a lower percent than the Hindus and Australians in carious teeth, and the lowest percent of malocclusion."

Adventitious Roots. By Smith (W. Ramsay)—*Proc. Fourth Austral. Dent. Congr.*, Aug. 1921, 109–114.

For years the author has been receiving all the extracted teeth from the dentists of Adelaide, and the collection—which the reviewer had the good fortune to see in 1925—has now reached important proportions. These teeth are all minutely examined by Dr. Smith and classified. One of the results of these studies, combined with those on animal teeth and on those of the Australian aborigines, is reported in the present paper.

Adventitious roots are no great rarity in man; their location and form are characteristics and they have a definite meaning. Their homologues "are found in the present-day ungulates as normal structures; in the human being there are found all gradations, from the simple form described, differing in size, shape and position, up to specimens in which it becomes impossible to say whether, in some cases, one is dealing with an adventitious root or the root belonging to a normal cusp or cusps."

The subject is bound up with the evolution of human teeth.

L'inaptitude dentaire des hommes préhistoriques. By Siffre (—)—*Sem. dent.*, 1925, VII, No. 12, 300–'8 & No. 13, 322–'8.

The author discusses especially the teeth of *H. rhodesiensis*, which due to both wear and caries are, as is well known, in a very poor condition. He is of the opinion that the main cause of this must have been improper nourishment.

Peg-Shaped Teeth and Dislocation of the Molars. By Smith (Ramsay)—*The Australian Dental Summary*, Mar. 1, 1925, 451–457.

The author discusses in an interesting way secondary dislocation of the molars, and especially tooth wear, as seen in the skulls of various races, more particularly the Australian aborigines. For him "the inference is fairly plain that 'much chewing' is the cause of the peg-shape of incisors and canines found in certain localities among a variety of races. One cannot say that the presence of sand in the food is a necessary condition, nor can one say to what extent local conditions and diet may act by producing predispositions to a bodily dyscrasia, as in the case of 'gouty teeth.' The bicuspids and molars also participate in the same changes, presumably from the same causes." The condition of "dislocation" of the molars is, as the author has pointed out, "often associated with the occurrence of peg-shaped incisors and canines...It appears from an examination of numerous specimens that the amount of change varies with the length of time the teeth have been employed in the exercise of chewing."

A Case of Congenital Absence of the Deciduous and Permanent Mandibular Central Incisors in Four Members of a Family. By Pitts (A. T.)—*Intern. J. Orthod.*, 1925, XI, No. 12, 1137–'39.

The condition was present in the four members of a family. There was no history of any similar anomaly either in the mother or father, or in any of their relations. The children were well-grown and healthy and otherwise normal.

School Dental Inspection in Queensland. By Haenke (E. W.)—*Proc. Fourth Austral. Dent. Congr.*, Aug. 1921, 177–188 (Adelaide, 1923).

"A detailed examination was made of the mouths of the entire school population in the State, embracing over 1,100 schools, with an attendance of over 100,000 children distributed through an area of 670,000 square miles of territory...Of the teeth of all children examined 28 per cent were found to be carious. In the case of boys 20.8 per cent of the permanent teeth and 38.9 per cent of the deciduous teeth were found to be so affected, whilst with the girls 19.8 per cent of the permanent set and 37.6 per cent of the first dentition were found defective...The largest aboriginal school visited had an attendance of just over 100 children, and amongst all the pupils examined the average number of carious teeth per child was found to be only one whilst the percentage of children possessing naturally sound mouths numbered nearly 50. Close observations regarding the oral conditions present revealed the interest-

ing and significant fact that, whilst among the older groups of children the natural forces of protection—the condition of the oral secretions, the structure and development of the teeth etc.—were opposed to the progress of caries to a rarely witnessed degree; in the mouths of many of the younger group of children, a distinct caries-favoring tendency was found in the condition of the saliva and a noticeable increase in the extent and prevalence of decay was observable in the teeth. The spectacle of such an increase in the percentage of caries amongst a section of the aboriginal children was viewed with grave concern and I was compelled to attribute the finding to the facilities, lately introduced at the mission store for the obtainment of sweets, biscuits etc., as in every instance investigation disclosed that the children whose teeth were affected by caries belonged to that exceptional class of family where the father, through regular periods of employment, was able to bring into the home more of the luxuries of civilization. The consequent train of dental caries was only too apparent and I could not do otherwise than officially recommend that restrictions should be placed on the quantities of biscuits and sweets made available to the children. To certain of the officials the deprivation of a pleasing form of diet did seem harsh opposition to the new order of a more generous dietetic provision for the aboriginal child, but, viewed in the light of its relation to the bodily health, such a thought soon faded into insignificance and the deprivement becomes rationally justifiable."

Dental Pathology of the Eskimo. By Leigh (R. W.)—*Dental Cosmos*, Sept. 1925.

"The Eskimo are a distinct type physically. The caribou, sea mammals and fish constitute their food. The Eskimo are characterized by an overdevelopment of the muscles of mastication, especially the temporalis. There occur comparatively few atypical teeth or instances of dental dystrophy. Malocclusion occurs in 11.4 per cent of skulls; these are almost entirely Class 1 (Angle) cases. The incidence of dental caries is about 1 per cent. The chewing of skins has produced considerable wear of the teeth and, in old persons, pulp exposure was brought about by this domestic habit. About 19 per cent of skulls evidence one or more periapical abscesses, these abscesses being resultant from abrasion, tooth-fracture or periodontoclasia. Several cases of osteomyelitis, osteoperiosteitis and sinusitis are evident. The Eskimo are afflicted with a high incidence of destructive degeneration of the investing dental tissues."

The article connects intimately with that published by the same author in this Journal (1925, VIII, No. 2).

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PALAEONTOLOGY OF THE HUMAN DENTITION

TEN STRUCTURAL STAGES IN THE EVOLUTION OF THE CHEEK TEETH[1]

WILLIAM K. GREGORY

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INTRODUCTION

The human upper and lower jaws in normal occulsion are part of a mechanism, the wonder and beauty of which are nowhere more fully appreciated than by the members of this Congress. Were these complex relations of upper and lower cusps and surfaces created perfect, at one stroke, have they always been as we now find them, or have they attained their present status after a long and gradual series of modifications from more simple beginnings? And how far, in the present imperfect state of our knowledge, can we begin to discern an orderly succession of stages in the evolution of the dental apparatus?

[1]Read before the First International Orthodontic Congress, New York City, August 16–20, 1926.

Since the evolution of the orthodontic relations of the human upper and lower teeth is thus clearly a phase of the general study of the evolution of man, it may be fortunate for me that I can say what I have to say now, before a new constitutional amendment makes the whole topic legally taboo and our next Congress in this country subject to closure by agents of the Federal Government. At least in New York at the present time it is still reasonably safe to lecture in public on the evolution of man, but all over this broad land fiery zealots, with the energy of the Hebrew prophets, are calling upon their followers to throw down the idols of the evolutionists. Thundering into loud speakers from a thousand pulpits, they brand the scientific doctrine of the evolution of man as a flimsy hypothesis. Professing their desire to purge and purify true science, they denounce as "pseudo-scientists" all university professors and laboratory workers who dare to teach anything contrary to the traditional belief that Adam was literally made out of the dust of the ground and Eve from one of Adam's ribs.

But it is vain for them to kick against the pricks. They may make it illegal to teach evolution in state-supported universities, colleges and schools, but they cannot stop the endless discoveries of facts that have made the gradual evolution of the body and mind of man one of the most reasonable and fully documented inferences in the whole field of the biological sciences.

The radio orators naturally feel no embarrassing doubts as to their own competence to dispose of the subject of the evolution of man after they have read a few popular works on the subject and have got hold of a few citations of so-called authorities who have expressed opinions supposed to be damaging to this or that point of the evolutionist's argument. The scientist, however, is necessarily more modest. He realizes that thousands of important details of the story of human evolution must ever remain in doubt, and that at the present time science has reached no brief clear-cut picture as to the general mechanism of evolution, that is, the precise manner in which Natural Selection, the Environment, and other factors finally overcome the conservative forces of heredity and induce a definite shift from one structural level to the next. The scientist, moreover, recognizes that there is no royal road to a first-hand knowledge of the broader aspects of the origin and evolution of man. He perceives that the evolution of man is only a special case of the evolution of animals in general, and so he must first labor unceasingly to disentangle and classify the myriad twigs and branches of the great tree of vertebrate life. Fortunately a small army of investigators,

namely, students of systematic zoology, comparative anatomy and palaeontology have long been fruitfully engaged in this field. Thousands of studies in the anatomy and classification of recent and extinct vertebrates, all quite unknown to the pulpit and public press, have supplied the outlines of a tolerably detailed picture of the main branches and twigs of vertebrate life and of the principal stages in the ascent from fish to man. From a wide synthesis of such studies it has been learned that the evolution of the vertebrates may be sketched under the following heads: first, the successive changes in the locomotor apparatus; secondly, the evolution of the respiratory, vascular and alimentary systems, the last including the masticatory apparatus; third, the evolution of the reproductive organs and methods; fourth, the evolution of the coördinating organs of the peripheral and central nervous systems.

Scores of millions of years ago in Devonian times we meet the relatives and forerunners of the fishes with limbs and lungs, the hardy pioneers that first struggled up out of the water on to the land. Next, in the time of the Coal Measures, we find both the varied amphibians not yet wholly freed from the water and the earliest common ancestors of the reptiles and of all higher types. Coming on to the Permian and Triassic ages, each many millions of years in duration, we encounter several grades of organization among the mammal-like reptiles and some of these almost deserve to be called pro-mammals, so progressive are they in locomotor and masticatory apparatus. Proceeding to the Jurassic ages we come upon true mammals, with the beginnings of the tritubercular type of molar teeth; and quite recently Cretaceous Placental Mammals have been discovered in Mongolia, which as we shall see, supply a long-needed link in the evolution of the molars. Passing to the Lower Eocene we find early representatives of that great order the Primates, which was destined eventually to give rise to man, and which even at that far-distant epoch was already distinguished by its superior development of eye and hand and brain. In the Lower Oligocene of Egypt we meet the first ancestors of the branch which was later to subdivide into the anthropoid apes on the one hand and the races of man on the other, and in the Miocene we encounter traces of various true anthropoids, among which are some that, according to my interpretation of the evidence, stand in or quite near to the common stem of man and the modern anthropoids. In the Lower Pliocene our anatomical records, apart from one or two debatable finds, are a blank, but in the Pleistocene we have in gradually ascending levels, first the *Pithecanthropus*, a true man although in a low stage of development,

secondly, the Dawn Man or *Eoanthropus* of England, thirdly, the Heidelberg man, fourthly, the Neanderthal man, and finally the Cro-Magnon, true *Homo sapiens*, and his successors of the late Palaeolithic, Neolithic, Copper, Bronze and Iron Ages.

At each stage of this long line of ascent we must analyse the known osteological and dental characters and endeavor to discover what forms lie in or near the line of human descent and which ones are leading off in various directions to the specialized side lines.

The ten structural stages in the evolution of the human cheek teeth described above are all represented by known forms, extending in time through ascending geological horizons from the Permo-Carboniferous to the Recent. Not one of them is in any sense hypothetical. The drawings depicting the verifiable facts of observation have been made with the most painstaking care by a skilled artist, Mrs. Helen Ziska, under the author's close and constant supervision.

FIRST STAGE, PERMO-CARBONIFEROUS: UPPER AND LOWER CHEEK TEETH ALIKE, CANINIFORM

With such a general sketch before us we may take up the special subject of the present paper, namely, the palæontology, or development in past ages, of the human dentition. And first let us pass over all the earlier stages in the evolution of the teeth, when in the ancestors of the air-breathing fishes the tough skin around the mouth, bristling with small shagreen denticles, through a change of function became useful in holding on to small living prey. We must begin rather with that primitive reptilian stage represented by the small pelycosaurian or theromorph reptiles of the Permo-Carboniferous (Fig. 1, Ia), in which the upper teeth were simple and laniariform with compressed enamel-covered crown, each tooth with a single root embedded in a socket. In such a reptile the teeth of the premaxillary and maxillary bone of the upper jaw overhang and alternate with the similar teeth of the lower jaw. This was the beginning of relations that still hold to some extent in the human jaws. It need hardly be said that, in such a simple mechanism, when the lower jaws are drawn upward by the action of the temporal muscle-mass the food is both pierced and sheared by the pointed, sharp-edged teeth.

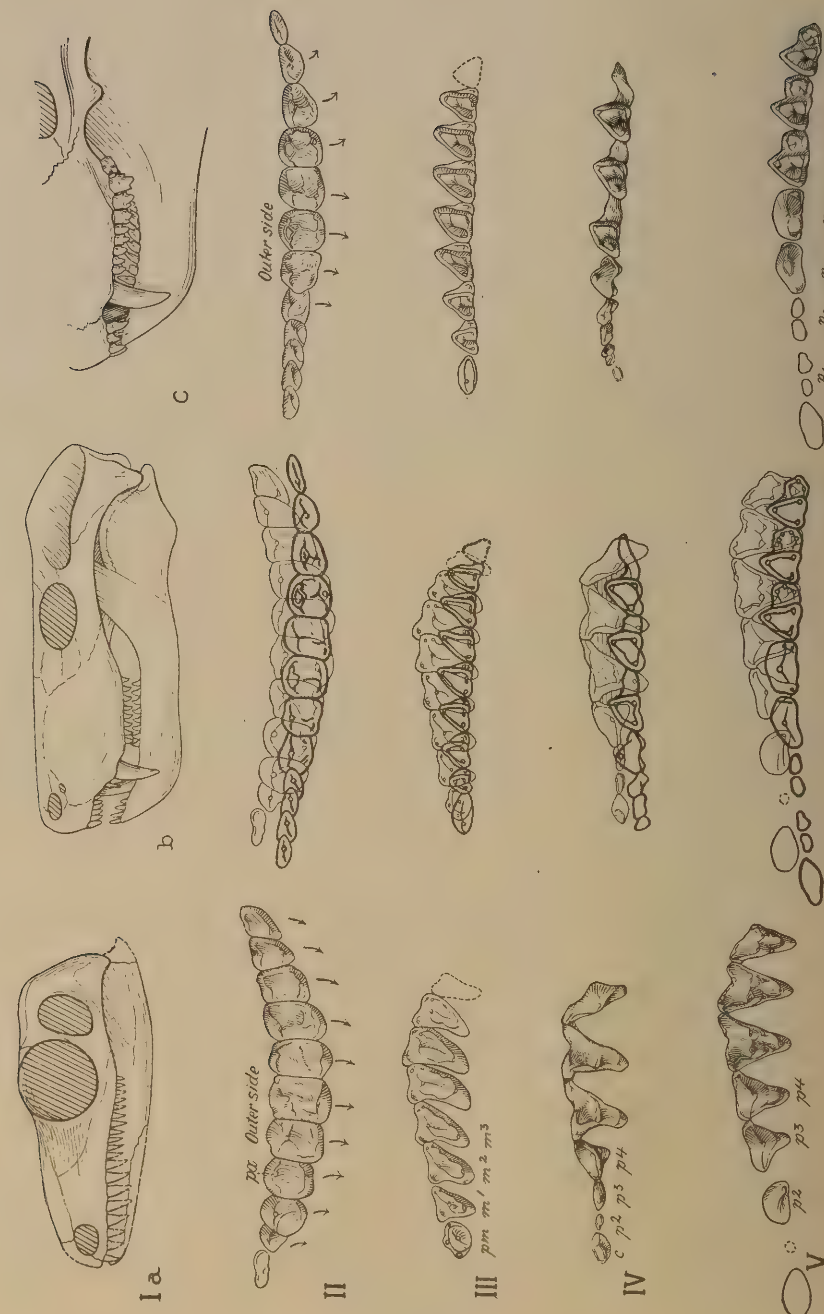
SECOND STAGE, TRIASSIC: "PROTOCONE" AND METACONID ARISE ON INNER SIDE OF UPPER AND LOWER MOLARS

The next stage of evolution is illustrated in the Pro-mammal or Cynodont reptiles of the Triassic of South Africa. For in them (Fig. 1,

Ic) the dentition has become differentiated into incisors, canines, premolars and molars, and the available evidence indicates that the succession of the teeth was reduced to two sets, corresponding to the deciduous and permanent series of mammals. In many genera of the Cynodonts both the upper and the lower cheek teeth were all compressed and shearing, with one or more accessory cusps on the margins of the shearing blade, but in some other genera of Cynodonts constituting the family Diademodontidæ (Fig. 1, II), while the original tips of the upper still overhung the tips of the lower cheek teeth, the upper molar teeth in the middle of the tooth row were extended transversely on the palatal side, while the corresponding lower molar crowns had acquired a subcircular outline with a transverse ridge across the summit of the crown. In such a dentition the upper and the lower teeth are markedly unlike, the uppers being transversely oval with a tuberculate transverse ridge, the lowers much smaller and circular but also with a transverse ridge. These Diademodont Cynodonts, if not themselves the direct ancestors of the mammals, were at least nearly related to such ancestors; they already exhibited the beginning of the power of developing a cuspidate molar crown, which became so marked a characteristic of the mammals themselves, and they were also extraordinarily mammal-like in many significant morphological characters of the skull. It is therefore significant that in all the Cynodonts the original tip of the molar crowns lies on the outer or buccal side in both the upper and the lower teeth; and that the upper and lower cheek teeth fall in inter-locking series such that each lower articulates with two uppers; also that the basal swellings on the lingual side of both upper and lower molars constitute the main overlapping parts of the crowns.

THIRD STAGE, JURASSIC: UPPER AND LOWER MOLARS UNLIKE, LOWERS FIT INTO INTERDENTAL EMBRASURES

The exact stages between the pro-mammal with compressed shearing teeth and the pretritubercular molars of Cretaceous mammals are still in doubt, notwithstanding the famous theory of Cope and Osborn as to the origin of the upper and lower triangles by rotation or migration of the accessory cusps outward in the upper and inward in the lower teeth. Unfortunately our present evidence does not permit us to confirm this theory, but on the contrary it indicates that the tritubercular molars of later mammals did not originate in this manner. A fundamental postulate of the Cope-Osborn theory was that the original tip of the ancestral reptilian tooth gave rise in the mammals, in the upper molars to the main



I a
b
c
II
III
IV
V
Outer side
Outer side
pm m1 m2 m3
c p2 p3 p4
p2 p3 p4
p1 p2 p3 p4

Fig. 1

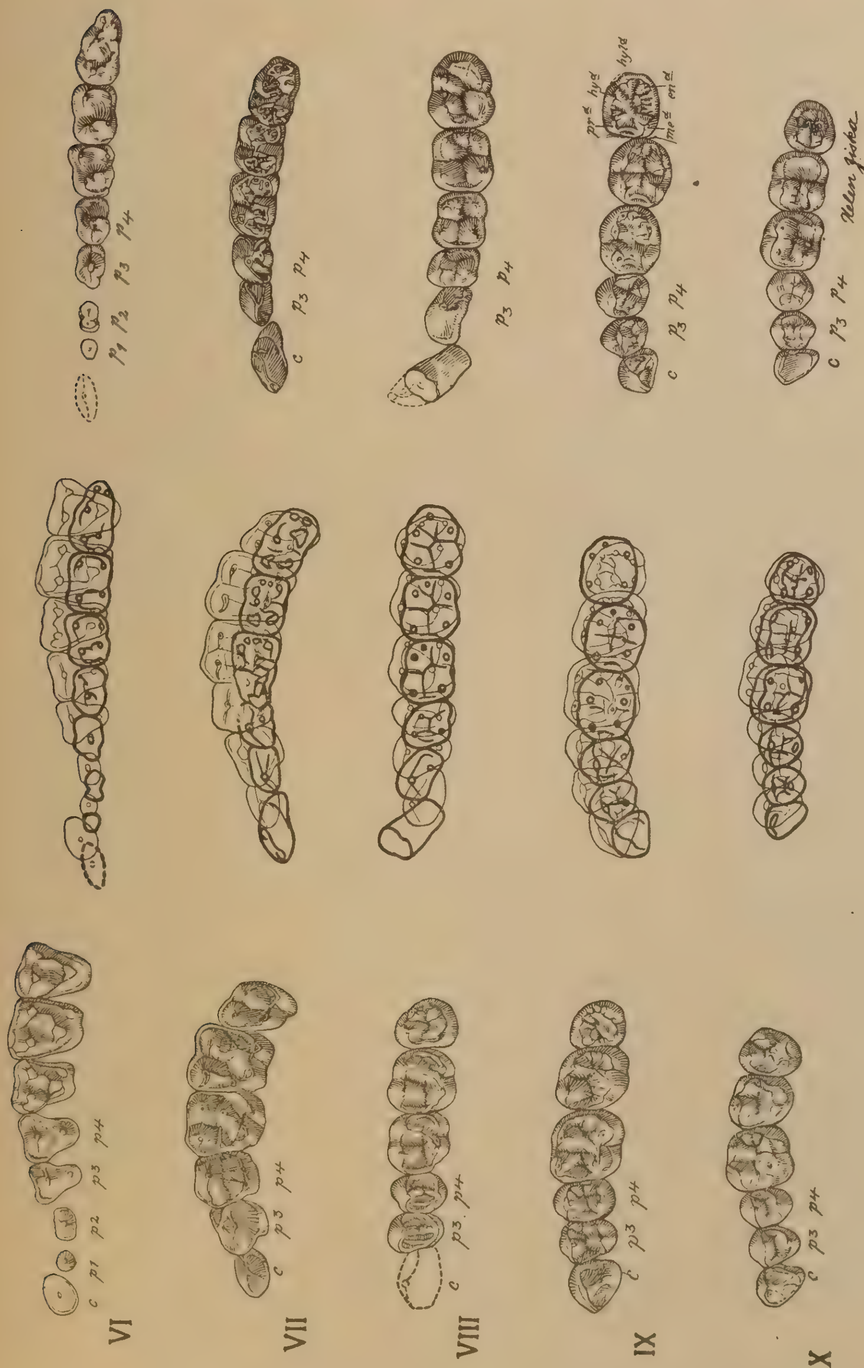


Fig. 2

Fig. 1. Ten Structural Stages in the Evolution of the Human Dentition, from Ascending Geological Horizons.

I. Substage *a*. Permo-Carboniferous. *Mycterosaurus*, primitive Theromorph Reptile. After Williston.

Substage *b*. Permian. *Scylacosaurus*, primitive Mammal-like Reptile. After Broom.

Substage *c*. Triassic. *Cynognathus*, advanced Mammal-like Reptile. After Seeley.

II. Triassic. *Diademodon*, advanced Mammal-like Reptile. Mainly after Seeley. Occlusion diagram by author.

III. Jurassic. Pantotherian (primitive pro-Placental). Kindness of Dr. G. G. Simpson. Occlusion diagram by Simpson.

IV. Cretaceous. Pre-Trituberculate, *Deltatheridium*. From the original specimen. Occlusion diagram by author.

V. Lower Eocene. Primitive Placental, *Didelphodus*. From the original specimen. Occlusion diagram by author.

Fig. 2. Ten Structural Stages in the Evolution of the Human Dentition (con't)

VI. Middle Eocene. Primitive Primate, *Pronycticebus*. After Grandidier. Occlusion diagram by author.

VII. Upper Eocene. Advanced Tarsioid Primate, *Microchœrus*. After Stehlin. Occlusion diagram by author.

VIII. Miocene. Primitive Anthropoid Primate, *Dryopithecus*. Upper molars mainly after Pilgrim; lower molars from type of *Dryopithecus cautleyi*. Occlusion diagram by author and Milo Hellman.

IX. Pleistocene. Primitve Man, Mousterian. From stereoscopic photographs by Professor J. H. McGregor and from the published photographs by Weinert and by Virchow (m_3). Occlusion diagram by author.

X. Recent. Modern Man, White. From the original specimen. Occlusion diagram by author.

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internal cusp, which was therefore called the protocone, and in the lower molars to the main external cusp, called the protoconid.

All the available evidence, both from the ancestral Cynodonts and from the mammals of the Cretaceous and Tertiary ages, now indicates that at least in the lines leading to the later mammals the supposed reversal of the relationship of the upper and lower original tips did not take place, but that on the contrary the original tips remained on the buccal side in both the upper and the lower teeth, while the inner basal part of the crown became extended toward the inner side to give rise to the crushing portions of the crown.

Another postulate of the Cope-Osborn theory was that in the supposed stage of "reversed triangles" the upper and lower molar crowns were exactly alike in form; but it now seems clear that at a very early stage the upper and lower molars became quite unlike, the uppers being larger, roughly triangular in form, with large interdental embrasures into which the small sharply triangular lowers fitted. At this stage (Fig. 1, III), represented by the Jurassic Pantotheria originally described by Professor Marsh and now most ably restudied by Dr. G. G. Simpson, the original tip of the ancestral reptilian tooth in the upper molar was

apparently represented by the main high cusp in the middle of the premolars and molar crowns, a cusp which was destined to give rise later to the mesiobuccal and distobuccal cusps (para-and metacones). From the anteroexternal (mesiobuccal) corner projected a rounded buttress, the parastyle, surmounted by a raised rim or cingulum, while from the posteroexternal (distobuccal) corner projected the metastyle. The internal angle of the triangular base of the crown was formed by a rounded protuberance terminating in a low cusp, the mesiopalatal cusp, or so-called protocone. The front side of the triangular basal section is relatively short and more transverse in position, the posterointernal (distolingual) side is longer and more oblique. Both these sides oppose the principal moving blades of the lower molars.

The lower molar crowns of this stage consist of two radically distinct parts, an elevated triad of cusps, the trigonid, and a small low posterior extension, the incipient heel or talonid. An important difference from the upper molars is that the homologue of the original tip is not central but external in position. The cusps of the trigonid of the lower molars in the Osbornian system of nomenclature are called protoconid (main external), paraconid (anterointernal), metaconid (posterointernal), and for convenience these names are retained, but with the express reservation that according to present evidence the cusps so designated are not severally homologous with the similarly named cusps of the upper molars.

If we reject, as seems necessary, the Cope-Osborn theory of the origin of the upper and lower triangles by the folding in opposite directions of simple triconodont teeth, and if we accept the evidence cited by various authors and tending to show that in both upper and lower teeth the original cusps remained on the outer or buccal side, then in the lower molars the first appearance of the paraconid and metaconid as distinct cusps must have been associated with the transverse, or obliquely transverse, widening of the crowns; and both these cusps arose *in situ*, the one at the anterointernal extension of the base of the crown and the other as a swelling on the inner or lingual slope of the original tip or protoconid. Meanwhile the so-called protocone or internal cusp of the upper molar is simply a cusp or swelling on the inner or palatal extension of the crown. It was not the original tip but it probably arose as far back as in the Diademodont forerunners of the mammals. In the occulusion diagrams (Fig. 1, II, III, IV) we can see the intimate functional relations of these parts of the upper and lower molars.

The protocones of the upper molars became differentiated, we may

infer, at the same time with the metaconids of the lower molars. Even in later mammals the metaconid blade shears in front of the anteroexternal blade of the protocone V, while the tip of the metaconid of the lower molar grinds against the anterior side of the protocone of the upper. In primitive insectivorous and carnivorous mammals the protocones are displaced forward, while the blade on the posterior slope of the protocone shears past the blade on the anteroexternal face of the metaconid. This situation is already developed in the Jurassic Pantotheria (Fig. 1, III).

The protocone of the upper molars very early came into functional relations with another element of the lower molars, namely the talonid or heel. In the predecessors of the mammals the upper teeth were set in a crowded series and there were probably few or no interdental embrasures. Moreover the pressure of the lower jaw seems to have been chiefly vertical and directly transverse, not obliquely transverse. The Triconodont mammals of the Mesozoic ages remained apparently in this stage of evolution. But the Pantotherian mammals of the Jurassic (Fig. 1, III) had already advanced to the stage where pressure of the lower jaw in an oblique anteroexternal direction accompanied a forward displacement of the internal extension or protocone of the upper molars, with a concomitant upgrowth of the paraconid and development of the paraconid blade, and finally with the opening up of the interdental embrasures.

Meanwhile the protoconid of the lower molars, from being directly above the median forking between the anterior and posterior roots, had shifted forward along with the protocone of the uppers, so that it finally came to lie more above the anterior root, leaving room on its posterior slope for the backward growth of a new and highly important structure, the talonid. This from the first impinged on the anterior slope of the protocone of the next succeeding upper molar, but by further growth the first cusp of the talonid, namely the entoconid, worked itself around behind the tip of the protocone.

By this time each upper and lower molar consisted of two functionally analogous parts: first, a shearing V and secondly, an overlapping heel. The shearing V of the upper tooth was formed by the anterior and posterior slopes of the protocone, more or less connected respectively with similar blades on the anterior and posterior corners of the crown (para- and metastyle). At this stage the large original tip of the upper molars (the future paracone) held aloof from articulating with any part of the lower molars, simply fitting into the interdental embrasures on the outer

sides of the lower molars and pressing the food against the nearby blades on its own base and on the sides of the lower teeth. The shearing V of the lower molar had its tip, the protoconid, on the outer side and its sides (the paraconid and metaconid) directed inward.

Here then we have the true functional reversal of upper and lower triangles which apparently misled Osborn and Cope into homologizing the upper and the lower reversed V's; but as already intimated, the reversed upper and lower V's both have the primitive apex of the tooth on the outer side of the crown, and in the upper the primitive tip stands not at the internal angle but in the middle of the V, while in the reversed lower V the original tip of the crown is located at the fork of the V.

The overlapping or crushing portions of the upper and lower teeth in this stage consisted in the lower molar of the small talonid, with its sole cusp the entoconid, and in the upper molar of the protocone, the tip of which already fitted into the basin of the talonid as it does in nearly all later mammals. Nevertheless I was formerly in error in supposing that the protocone of the upper and its functional mate the talonid of the lower were of equal age. The protocone apparently arose as early as the Diademodont premammalian stage and accompanied a transverse widening of the crowns; the talonid arose later in an early Pantotherian stage and its appearance was made possible by an anteriorward displacement of the metaconid, associated with an anterior displacement of the protocone of the upper molar.

Thus by Lower Jurassic times the upper and lower cheek teeth of mammals, as illustrated in the Pantotheria, had already attained rather complex interrelationships, and such a dentition as that of *Amphitherium*, which was not dissimilar to that shown in Fig. 1, III, had in it the morphological potentiality of the highly diverse arrangements and patterns of the molars that are found in existing placental and marsupial mammals.

FOURTH STAGE, CRETACEOUS: PRETRITUBERCULAR UPPER MOLARS WITH CONNATE PARA- AND METACONES

Until quite recently there was a considerable structural gap and an enormous chronological gap in the record of dental evolution between the Jurassic Pantotheria and the swarming placental mammals of the Eocene and later ages. Owing to this gap in our records it has been in doubt, for example, whether the internal extension of the protocones of the Pantotheria was truly homologous with the so-called protocones of the molars of later mammals, whether the protocones of later mammals arose *pari passu* with the development of the talonids, and so forth.

But these doubts have at last been resolved, in my own mind at least, through the fortunate discovery by the Third Asiatic Expedition of the American Museum of Natural History, under the leadership of Roy Chapman Andrews, of the long-sought Cretaceous mammal skulls. These priceless specimens, which have recently been described in a joint paper by myself and Dr. G. G. Simpson of Yale University, still retain certain primitive features inherited from the Jurassic Pantotheria: thus their main high central cusps are still flanked on the outer sides by prominent parastyle and metastyle projections, while the basal section of the crown is obliquely and asymetrically triangular with the internal apex displaced anteriorly.

On the whole the Cretaceous mammals are already nearer in dental structure to the later placental mammals than to the Jurassic Pantotheria. In one of them, which we have named *Deltatheridium pretrituberculare*, as indeed also in the others, the upper molars (Fig. 1, IV, Fig. 2) show a further progression beyond the primitive Pantotherian condition in the direction of those of typical later mammals. In the first place, the total number of postcanine teeth has been much reduced, from about eleven or twelve to six or seven, the reduction apparently having occurred through the loss of the posterior molars, so that seven larger teeth now occupy the whole tooth row instead of twelve small ones. Secondly, the interdental embrasures of the upper teeth have widened to accommodate the enlarged talonid of the lower teeth. Thirdly, the talonids of the lower molars have now captured and definitely engage with the entire protocone of the upper molars, the latter being reduced to the condition of a pestle that works in the basin of the talonid. Fourthly, the main central cusp of the upper molar has assumed a more dominant position, since the blades on its anteroexternal and posteroexternal slopes now shear past the blades on the corresponding slopes of the protoconids. Fifthly, the main central cusp, the original "reptilian cone" is now in process of being divided into two cusps, still connate at the base, the para- and metacones (mesiobuccal, distobuccal).

FIG. 3. Palate of Primitive Placental Mammal (*Deltatheridium pretrituberculare*) from the Cretaceous of Mongolia. X 2/1

Another of these Mongolian Cretaceous genera described by us (*Zalambdalestes*, Fig. 4), although more in the line of ascent to the

Zalambdodont insectivores than to the higher Insectivora, shows a further advance in the direction of later mammals in that the trigonid is now completely displaced to the forward part of the crown, while the talonid is widened transversely and is now even wider than the trigonid. In correlation with this transverse widening of the talonid the main

FIG. 4. Right Lower Cheek Teeth of Primitive Insectivore (*Zalambdalestes lechei*) from the Cretaceous of Mongolia. X 3/1.

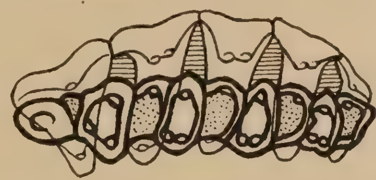

FIG. 5. Occlusal diagram of *Zalamb dalestes lechei* X 5/1.

external cusp of the upper molar, already subdivided into the para- and metacones, is retreating toward the outer border of the crown (Fig. 5).

These Mongolian Cretaceous genera of placental mammals (Fig. 6, A, B, C) combine the characters of the insectivores and carnivores of the Eocene and later ages to such a degree that we regard them as standing in or quite close to the common ancestry of these two orders. And it has long since been inferred from numerous comparative studies that this

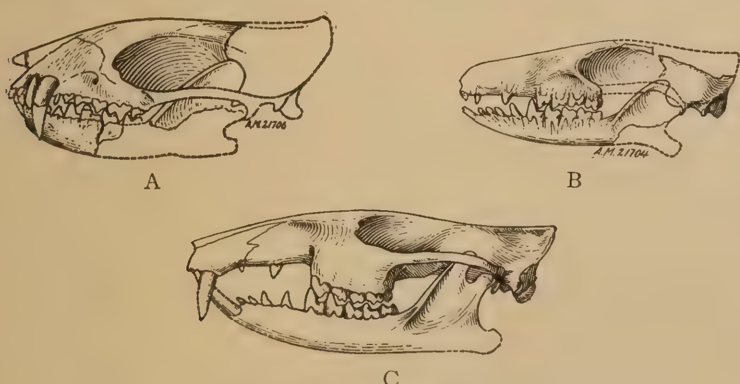

FIG. 6. Skulls of Cretaceous mammals from Mongolia.
A. *Deltatheridium pretrituberculare.* X 1.
B. *Zalambdalestes lechei,* young. X 1.
C. *Zalambdalestes lechei,* extremely old X 1.

hitherto undiscovered primitive insectivore-carnivore group also constituted the common stock of all the later placental orders, including the Primates.

It would be too much to expect that the first discovered Cretaceous

placental mammals should be the very ones that would tend to bridge the gap between the Jurassic Pantotheria and the Eocene and later placental mammals and yet such is the fortunate fact. It had already been inferred by several authors from comparative studies of Eocene and later mammals that the main high cusp of the upper molars, standing in line with and behind the similar main cusp of the premolars and likewise supported equally by the two main roots on the outer side of the crown, was serially homologous with that cusp; in other words, that the paracone and not the so-called protocone represented the summit of the original reptilian crown. But in the Cope-Osborn theory of reversed triangles this fact was ignored, although it was tacitly admitted that in the lower molars the main high cusp of the molars, the protoconid, was homologous with the main high cusp of the premolars in front of it. This inherent inconsistency of the Cope-Osborn theory was exposed by me in 1916, and in 1922 I showed that the occlusal relations of the upper and lower cheek teeth made it far more probable that in the upper molars the homologue of the original reptilian cone was the paracone or

FIG. 7. Relations of Main Tips of Molars and Premolars in a Primitive Cretaceous Placental (*Deltatheridium pretrituberculare*).

A. Oblique rear view of left lower cheek teeth, showing the protoconids of the molars in line with the tips of the premolars.

B. Oblique rear view of right upper cheek teeth, showing the high paracone in line with the tips of the premolars and the "protocone" as a low process from the base of the paracone.

the combined para- plus metacone. The newly discovered Mongolian Cretaceous placental mammals afford strong support to this view, namely that in the upper teeth the original reptilian tip lies on the paracone and that in the lower molars it is the protoconid. These relations may be seen at a glance in Fig. 7; hereafter the burden of proof

must be upon anyone who would maintain that in the upper jaw the original reptilian tip shifts as we pass backward from the main high cusp to the internal basal extension, the so-called protocone.

FIFTH STAGE, LOWER EOCENE: TYPICAL TRITUBERCULAR UPPER MOLARS AND TUBERCULO-SECTORIAL LOWER MOLARS

From the Cretaceous Mongolian placentals to the highly varied placentals found in the Basal and Lower Eocene of North America is but a short step. Already in the Lower Eocene and perhaps even earlier the Order of Primates had become separated from other mammals. The existing Tree Shrews (Tupaiidae) of Borneo and adjacent regions seem to be living and but little modified survivors of the basal Primate stock, so that after many studies on their anatomy and osteology certain authors classify them as the first division of the Primates rather than as a highly progressive family of Insectivores. While they have become more or less specialized in their front teeth, their cheek teeth have retained many features seen in the Cretaceous placentals and in other primitive placental mammals of Eocene times.

But to illustrate the passage from the Cretaceous to the Eocene, in the line of ascent toward man, I have chosen a form that is not a primate at all but is of so generalized a type that according to Dr. W. D. Matthew it can most conveniently be referred to the Order Insectivora. I refer to the Lower Eocene genus *Didelphodus* (Fig. 1, V). In this genus we see very clearly several distinct advances upon the conditions characteristic of the Mongolian Cretaceous mammals. This dentition affords an ideally central type for the derivation of all specialized molar patterns of later placental mammals, although it must be borne in mind that since *Didelphodus* is a Lower Eocene rather than a Basal Eocene or even Upper Cretaceous form, it was even in its own day a relic of still older forms and that it lived beside more progressive contemporaries that had already attained more advanced modifications of the dentition in several directions.

Didelphodus then, representing a primitive placental stage of the dentition, had advanced beyond the more primitive *Deltatheridium* of the Cretaceous in the following respects: first, it was no longer in a pre-tritubercular stage, since the para- and metacones of its upper molars were now well separated, thus producing the typical tritubercular upper molar, which Cope and Osborn rightly chose as the starting point for the more complex molar patterns of all higher placental mammals. Secondly, the lower molars had attained the typical tuberculo-sectorial

condition with a nearly balanced development of the trigonid and talonid.

That this combination of tritubercular upper molars and tuberculo-sectorial lower molars was in very truth the starting point for the diverse molar patterns of later mammals would need no emphasis if addressed to the few living palæontologists who have devoted their lives to the study of the swarming families of Eocene and later fossil and recent mammals. But unhappily the published evidence for this statement is scattered in scores of technical papers and the main bulk of the evidence can hardly ever be published at all by reason of its very extensiveness. It is therefore still possible even for certain eminent students of anthropology and human morphology to treat with equal scepticism all theories of the early evolution of the molar teeth of mammals and to imagine that they can safely start *de novo* and invent a new theory each one for himself.

But to return to *Didelphodus*, it does, as I have said, present ideally primitive upper and lower molar patterns. Every one, but one, of the standard main cusps of the typical primitive placental molar is present and normally developed. The proto-, para- and meta- cones, the protoconule and metaconule and the para- and meta- styles are all present and functioning normally, as may be seen in the occlusion diagram (Fig. 1, V).

The one molar cusp which normal placental mammals now have and which *Didelphodus* had not yet developed is the hypocone, a later derivative of the posterointernal region of the crown. In *Didelphodus* the well developed trigonids still fit into the interdental embrasures, the talonid had not yet outstripped the trigonid in size, and its hypoconid had not yet pushed its way laterally beyond the line of the inner bases of the protoconids.

SIXTH STAGE, MIDDLE EOCENE: APPEARANCE OF THE HYPOCONE AND REDUCTION OF THE PARACONID; FIRST WIDENING OF THE TALONID.

Nature's beautiful mechanisms sooner or later get thrown out of balance and seek new adjustments through the overgrowth and crowding of certain parts and the retreat and final disappearance of other parts. This phenomenon is clearly illustrated in Fig. 2, VI, representing one of the numerous Primates of the Middle Eocene and quite representative in a general way of all its relatives. For in this form the primitive trigon of the upper molar has become modified by the addition of a fourth main cusp, the hypocone, which in this case is derived from a

swelling on the posterior cingulum or basal ledge. The upgrowth of this hypocone tends to reduce and finally to obliterate the interdental embrasure and to transform a triangular tritubercular upper molar into a quadrangular quadritubercular one. This process has not yet affected the third molar, is just beginning in the first, and is well advanced in the second molar.

Meanwhile the talonid of the lower molars has increased rapidly in size so that it now surpasses the trigonid; its hypoconid pushing laterally has passed the line of the protoconids and invaded the space formerly occupied by the main high central cusp; while the para- and metacones, derivatives as we have seen of the primitive central cusp, have not only parted widely from each other but have retreated laterally before the advance of the hypoconid. Meanwhile the paraconid is apparently being crowded out of existence, at any rate, it retreats before the backwardly-growing talonid of the preceding tooth and before the inwardly-growing hypocone of the upper molars. Thus, as first perceived by Cope and Osborn, we have the upper molars transformed from the tri- to the quadritubercular stage and the lowers from the tuberculo-sectorial into the tubercular stage with four main cusps, the protoconid and hypoconid on the outer side, the meta- and entoconids on the inner side.

A fifth small cusp, the hypoconulid, on the median posterior border, had already appeared in the primitive placentals (Fig. 1, V). In the earlier Primates it was poorly developed on the first and second lower molars, but large and prominently developed on m_3; it occluded on or slightly behind the posterior basal cingulum of the upper molar especially in m_3, where it formed a powerful piercing organ since it was located far back near the fulcrum and having a small area, its piercing power was correspondingly high.

In this Middle Eocene primate (*Pronycticebus*, Fig. 2, VI) we observe that while the first and second upper premolars are small, the third and fourth are tending to be subequal and bicuspidate. A further emphasis of this difference together with a crowding of the whole tooth row might result in the entire elimination of the first and second premolars, so that the originally third premolar would be in contact with the canine. This condition is realized in certain progressive tarsioid primates of the Upper Eocene (e.g., *Microchœrus*, Fig. 2, VII) and in all the Old World monkeys, anthropoid apes and man.

SEVENTH STAGE, UPPER EOCENE: UPPER MOLARS (m^1, m^2) QUADRITUBERCULAR; LOWER MOLARS WITH PROMINENT HYPOCONULID

Microchœrus itself is distinctly too specialized in certain particulars to lie in the direct line of human ascent. Nevertheless it belongs to a division, the Tarsioidea, which in many respects is progressive. Its skull is distinctly progressive toward the higher primate type and as investigations multiply it seems more and more probable that the line leading to the higher primates including man, branched off from the tarsioid stem before the latter acquired its various aberrant specializations. Therefore it seems legitimate to consider the molar patterns of *Microchœrus* (Fig. 2, VII) in the present connection, since in many ways they are intermediate between the primitive primate stage typified by *Pronycticebus* and the common stem leading to the anthropoids and man.

First, then, *Microchœrus* shows a marked advance beyond *Pronycticebus* in the development of the hypocones, which have now very nearly obliterated the interdental embrasures. Concomitantly the paraconids of the second and first molars are nearly or quite gone, but the paraconid of the first molar is still well developed in harmony with the feeble development of the posterointernal cusp of the fourth upper premolar. Secondly, the talonids now considerably surpass the trigonids in size, the hypoconids being predominant over the protoconids. Accordingly the para- and metacones of the upper molars are larger and even further separated than they were in *Pronycticebus* and lie still nearer to the outer border of the crown. This outer border from its great prominence in the earlier stages is thus greatly reduced, the external cingulum being the last trace of its former extensive development. A specialization of *Microchœrus* is the great development of the metaconule, which occludes behind the enlarged hypoconid and occupies the field left vacant by the retreat of the metacone. Another specialization is the doubling of the hypoconulids in the lower molars, which occlude in the space in front of and between the metaconule and the hypocone.

EIGHTH STAGE, MIOCENE: WIDENING OF THE LOWER MOLARS; APPEARANCE OF THE *Dryopithecus* PATTERN.

The upper teeth (Fig. 2, VIII) of the primitive anthropoid *Dryopithecus* from the Miocene of India and Europe exhibits a marked advance beyond earlier Primates and in the human direction in many particulars. In the first place the two premolars remaining out of the original four, namely p^3, p^4, are both fully bicuspid and have become closely similar in form. In the upper molars all the cusps have lost their crested shearing

form and have become obtusely conical. They have lost all trace of the original outer border of the crown and they have lost the protoconules, retaining however in a somewhat modified form the anterior cingular ridge connecting with the anterior crest of the protocone. The metacones have become somewhat smaller than the paracones and do not project so far laterally. The metaconule, no longer distinct, has apparently been fused with the base of the metacone, the well developed hypocone has reduced but not wholly obliterated the interdental embrasure. The third molar has acquired an irregular outline, usually broader on the inner than on the outer border.

Meanwhile the lower cheek teeth have undergone profound modifications. The anterior lower premolar (corresponding to the third of the primitive dentition) has remained compressed and is only incipiently or potentially bicuspid. The posterior premolar, on the contrary, is definitely bicuspid with a tendency to become molariform by the development of the talonid. The most conspicuous advance in the molars lies

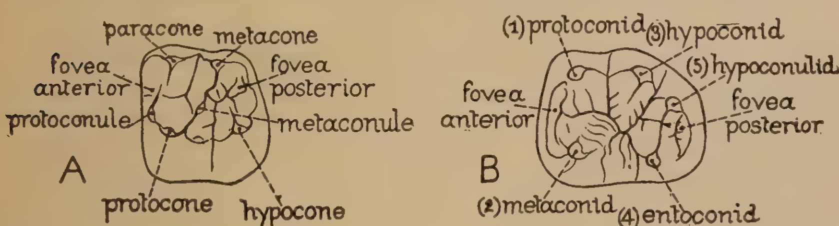

FIG. 8. Names of the cusps of the upper and lower molars of *Dryopithecus*, according to the Osbornian System.

in the marked changes in the proportions; the width of the tooth in proportion to its length has materially increased in comparison with the earlier Primates, especially in m_2. The ridges on the cusps, that formerly formed the shearing blades, are vestigial or absent, the cusps themselves having become very large and conical and being arranged in two main pairs, the first pair (protoconid-metaconid) transverse, the second pair (hypoconid-entoconid) obliquely transverse, with the entoconid a little behind the hypoconid. The hypoconulid varies somewhat in the different species of *Dryopithecus* but especially on m_2 is a prominent conical cusp lying obliquely behind the hypoconid. With the complete loss of the paraconid, the whole trigonid basin has been reduced to a narrow fissure, the "fovea anterior;" while a forward displacement of the protoconid, together with the widening of the whole tooth and the flattening down of all the cusps, has effected a great in-

crease in size of the talonid basin, which now forms the great central fossa of the tooth. With the reduction in height of the trigonid and the levelling of the general surface of the crown there has been an almost complete loss of the old tuberculo-sectorial pattern and functions. The shearing-grinding effect of bluntly conical cusps grinding past each other has taken the place of the shearing effects of delicate sharp-edged blades of the earlier trigonid, while the crushing-shearing-grinding function of the talonid has become dominant. With the loss of the sharp blades on the trigonid and talonid the conical cusps are no longer integrated into the primitive tuberculo-sectorial pattern, but a new pattern called the *Dryopithecus* pattern has grown up in place of it. This pattern (Fig. 2, VIII) consists of the collocation of the five main cusps in the positions already noted and with their bases defined by certain deep sulci, which during development appear along zones of contact between the expanding centers of growth of the five main cusps. An essential feature of the *Dryopithecus* pattern is that there is such a zone of contact between the posteroexternal slope of the metaconid and the anterointernal slope of the hypoconid.

The occlusion diagram of *Dryopithecus* brings out even more closely the functional significance of the characters already noted. As compared with the occlusion diagrams of earlier forms it reveals the marked increase in width of the lower as compared to the upper teeth, the complete loss of the primitive shearing blades of the trigonid, the enhanced functional importance of the talonid and of the hypoconulid, the lateral growth of the hypoconid between the paracone and metacone. As a whole there is decidedly less alternation between the upper and lower teeth than there was in the primitive stages; that is, the reduction of the trigonid and the increase of the talonid causes each lower tooth to articulate more with the correspondingly numbered upper tooth than with the preceding upper tooth.

But beneath these changes the old fundamental relations of the main cusps of the upper and lower molars are still very apparent. Thus the remnant of the trigonid still lies between two upper teeth, the hypoconid articulates between the para- and the metacone (although further laterad), the protocone still falls between the metaconid and the entoconid and the latter articulates on the anterior slope of the hypocone.

NINTH STAGE, PLEISTOCENE: FURTHER WIDENING OF THE LOWER MOLARS

The oldest human dentition known in which complete upper and lower sets belong to one individual is that of the fossilized skull of a young man of the Neanderthal race (*Homo neanderthalensis*) discovered

at Le Moustier in France and described originally by Klaatsch as *Homo mousteriensis hauseri* (Fig. 2, IX). From stereoscopic photographs taken by my colleague Professor J. H. McGregor and from an excellent cast of the specimen presented to the American Museum by Dr. J. Leon Williams, I am enabled to give diagnostic drawings of the upper and lower cheek teeth and to construct a diagram of the upper and lower teeth in occlusion. The European anthropologists who have described this dentition stressed its resemblances to and differences from other specimens referred to the Neanderthal race and to *Homo sapiens* and have said nothing about the whole series of fundamental characters which it has inherited from earlier primates and which the present series of drawings brings into sharp relief.

As to the upper cheek teeth, most of the description of the upper teeth of the anthropoid *Dryopithecus*, given above, would apply word for word to this human specimen. Thus on each side of the palate there are not only the same number of cheek teeth, but also the same total number of principal cusps on each corresponding tooth, as follows:

	P^3	P^4	M^1	M^2	M^3	Total
Dryopithecus	2	2	4	4	4	16
Le Moustier	2	2	4	4	4	16

Moreover, each one of the corresponding cusps and ridges has the same general character in the Mousterian youth as it has in *Dryopithecus*.

The lower cheek teeth of Le Moustier likewise show the same number of teeth and the same total number of principal cusps as in *Dryopithecus*, as follows:

	P_3	P_4	M_1	M_2	M_3	Total
Dryopithecus	2	3–4	5	5	5	20–21
Le Moustier	2	3–4	5	5	5	20–21

Except in the third lower molar, in which the fundamental pattern has been obscured by secondary grooves and wrinkles, as it sometimes is in the Chimpanzee and still more in the Orang, the *Dryopithecus* pattern is still evident in the lower molars of Le Moustier, which retains the essential contact between the adjacent bases of the metaconid and hypoconid.

Moreover the occlusion diagrams reveal the extraordinary degree of correspondence between *Dryopithecus* and Le Moustier in all fundamental characters, so that it may be stated as a fact that in the general pattern and in the occlusal relations of its cheek teeth, the primitive anthropoid *Dryopithecus* is far nearer to the primitive human stage represented by Le Moustier than it is to the early primate *Pronycticebus*. For example, the tendency toward an end-to-end rather than a broadly

alternating relation of the upper and lower molars, already established in *Dryopithecus*, is retained in Le Moustier, which is in this respect much nearer to *Dryopithecus* than the latter is to *Pronycticebus*.

Finally, many of the differences between *Dryopithecus* and Le Moustier represent further advances in the same direction in which the former differs from primitive primates. In Le Moustier, for example, p_4 has progressed considerably toward the molar pattern since its posterior moiety and its incipient hypoconid and entoconid are now better developed than they were in *Dryopithecus;* p_3 from being at most incipiently bicuspid has become completely so, its main axis now being transverse instead of anteroposterior. But that this difference between Le Moustier and *Dryopithecus* may fairly be classed as merely a progressive character of the former and not a divergence tending to remove *Dryopithecus* from the line of human ascent, is indicated by the wide degree of variability in the form of p_3 among recent chimpanzees and gorillas, in some of which p_3 retains largely the compressed *Dryopithecus* form, while in others the crown of p_3 has been rotated so that the direction of its main axis is obliquely labiolingual, its lingual border bearing a strong cusp, so that the tooth as a whole approaches the bicuspid type.

In the lower molars of Le Moustier the broadening of the crown has progressed much further than it had in *Dryopithecus;* m_3 has completely lost its tuberculo-sectorial character and has gone a step further on the road toward degeneration, delayed eruption and eventual disappearance. The hypoconulid, but moderately developed in *Dryopithecus*, is larger in Le Moustier, especially in m_1. Turning again to the occlusion diagram we note in Le Moustier the further tendency of the hypoconulid to crowd into the territory formerly occupied by the hypoconid, with an associated tendency in m_1 for the hypoconid to expand laterally.

But in addition to all these characters in which Le Moustier has either retained the pure *Dryopithecus* status or progressed further in the same direction in which *Dryopithecus* had advanced beyond the earlier primates, we witness many new features in Le Moustier which were in general associated with a profound change in the form of the dental arch as a whole. For whereas in primitive anthropoids the jaw is relatively narrow transversely, the opposite halves of the lower jaw and the opposite rows of cheek teeth being more or less parallel, in man the mandible has been greatly widened and shortened, the front part of the alveolar border crowded backward, so that the lower incisors and canines are no longer procumbent, but in the more advanced races even

pass the vertical. Meanwhile the canine tooth has diminished in length and its tip has finally withdrawn beneath the closed up row of upper teeth, while the forepart of the dental arch has shrunk transversely so that the premolar series incline more toward the midline, all these changes producing the characteristic paraboloid upper and lower arches which had already been attained in the Pleistocene species of man represented by Le Moustier.

It is true that apart from the doubtful exception of the Talgai palate we do not yet possess the structurally intermediate stages between the *Dryopithecus* condition with narrow dental arch and enlarged canines and the condition seen in Le Moustier and other early human races in which the canine is definitely human. But in view of the extraordinary resemblances in the cheek teeth already noted, taken in connection with the cumulative evidence from comparative anatomy as to the derivation of the human family from a primitive anthropoid stock, there can be little reasonable doubt that there once were such intermediate stages, in which the lower canine was smaller and more erect than in the primitive anthropoid and the front part of the jaw already in course of being crowded backward. Indeed the mandible of the Piltdown race may, when its front part is better known, afford just such an intermediate stage.

The lower molars of the Mousterian youth also exhibit another major advance toward the modernized human stage, since its second molar already shows signs of substituting the cruciform for the *Dryopithecus* pattern. That is, with the crowding forward of the entoconid the transverse sulcus in front of the entoconid has been brought nearly in line with the transverse sulcus between the protoconid and the hypoconid. Meanwhile the pairing of the hypo- and entoconid in a transverse row prepares the way for the completion of the cruciform pattern in the present stage of evolution.

TENTH STAGE, RECENT: REDUCTION OF THE HYPOCONE OF M^2, DELAYED ERUPTION OF $M\frac{3}{3}$, LOSS OF THE *Dryopithecus* PATTERN, M^1 AND M_1 DOMINANT

The cheek teeth of modern man, as the members of this Congress well know, vary widely both in size and form, but the dentition of the female Bedouin illustrated in Fig. 2, X. may be taken perhaps as fairly representative for the white race.

That this dentition is in some respects considerably simplified and reduced, as compared with the more vigorously developed dentitions of infra-human primates, there can be no reasonable doubt. Professor

Cope long ago noted that in certain races, especially the Esquimaux but also in allied Mongolian races, there was a tendency for the second upper molar to exhibit only the three "primary cusps," the fourth or hypocone being reduced or absent. Cope spoke of this phenomenon as a "reversion" to a "lemurine" "tritubercular" stage of evolution but the use of the words reversion and lemurine only brings in an unnecessary and confusing element of mystery. For all stages in the reduction of the hypocone may be observed in any large collection of human skulls. Moreover, the occlusal relations of the three main cusps are substantially the same as in the quadritubercular second molars of Le Moustier and *Dryopithecus*, to both of which the resemblance is far closer than to the tritubercular second upper molar of primitive Eocene primates.

The third upper molar in this fully adult individual is well developed but was not yet in contact with the third lower molar, this delay in assuming its functional responsibilities presaging the final degeneration of these teeth attained in some human jaws.

Along with the diminution in size of m^2, m^3, as compared with the corresponding teeth of older types, we observe in this Bedouin the dominance of m^1 and of its fellow in the lower jaw, which is one of the outstanding features of modernized human dentitions.

In the lower molars we now find another conspicuous reduction,—namely the loss of the hypoconulid as a distinct cusp,—in which the modernized dentition has sacrificed some of the features slowly won through long geological ages and in which there is a marked tendency toward simplification. The reduction of the hypoconulid has been traced again and again by numerous observers, in various races and individuals. In general this loss is more pronounced in m_2 than in m_1, which although progressive in dimensions is more conservative in pattern than m_2. Usually with the loss of the hypoconid of m_2 the substitution of the plus-shaped or cruciform arrangement of the principal sulci has been completed.

As a result of the changes in dimension noted above we find that with regard to anteroposterior length m_2 is usually shorter than m_1 it is also longer than m_3. This is the direct opposite of the relations obtaining in *Dryopithecus*, where the molars typically increase in length from m_1 to m_3, but many intergrading conditions between these extremes have been observed in fossil and recent human jaws.

Another marked characteristic of such modernized dentitions as that shown in Fig. 2, X is for the two upper bicuspids to become like each other; a similar tendency is seen in the two lower bicuspids. The

result of all these modifications is an apparent simplicity and a degree of resemblance between adjacent teeth which has led some authors to far-reaching theories of the early evolution of the teeth, based upon the development or upon the teratological variations in modernized human teeth.

Who would have suspected, from an examination of the human dentition in its present simplified condition, that it had passed through the long and complex series of changes which we have followed above?

SUMMARY AND CONCLUSIONS

Unfortunately the detailed labors of palaeontologists and of students of the major classification and evolution of the mammals are so little known to most of their own colleagues in other branches of the biological sciences that few can realize from first-hand knowledge that the study of the evolution of human molar teeth is no longer in the vague stage of fog and uncertainty. The cumulative and ever-widening evidence for Darwin's view that man is an off-shoot from the base of the anthropoid stem securely links the study of the evolution of human cheek teeth with the history of dental evolution in the infrahuman primates. And here we have clear documentary evidence, resting on no hypothetical stages, that enables us to follow the patterns of the human dentition backward to the *Dryopithecus* stage, thence to the primitive Primates of the Eocene, the dentition of which in turn closely approaches those of many other Eocene phyla that sprang from the central tuberculo-sectorial Placentals of Basal Eocene times. The discovery of definitely pre-tritubercular Placental mammals in the Cretaceous of Mongolia carries the history backward to a point near or at the origin of the "stem Placental" mammals, long expected but never hitherto known from fossil specimens. Back of this the long gap to the very beginnings of the future tritubercular stock in the Lower Jurassic still remains to be explored in detail, but even from present evidence little doubt can remain that the relation of reversed triangles between the upper and lower molars was not arrived at by the steps inferred by Cope and Osborn but took the general course inferred in outline by Wortman and several subsequent authors. The known Jurassic Pantotherian mammals again are advanced far beyond the most advanced mammal-like reptiles of the Triassic, but these in many respects are nearer in structure to the mammals than they are to the stem reptiles of the Permo-Carboniferous. Among the latter *Seymouria* again divides the difference between the most primitive amphibians and the typical reptiles, while there is the strongest morphological and palaeontological evidence for

connecting the amphibians with some undiscovered group of air-breathing fishes related both to the Fringe-finned Ganoids and the Dipnoans. Reading the story the other way, the ten structural stages in the evolution of the human cheek teeth, as described in the present paper, may be summarized as follows:

I. Substage *a*. Permo-Carboniferous. *Mycterosaurus*, primitive Theromorph Reptile.
   Substage *b*. Permian. *Scylacosaurus*, primitive Mammal-like Reptile.
   Substage *c*. Triassic. *Cynognathus*, advanced Mammal-like Reptile.
II. Triassic. *Diademodon*, advanced Mammal-like Reptile.
III. Jurassic. Pantotherian (primitive pro-Placental).
IV. Cretaceous. Pre-Trituberculate, *Deltatheridium*.
V. Lower Eocene. Primitive Placental, *Didelphodus*.
VI. Middle Eocene. Primitive Primate, *Pronycticebus*.
VII. Upper Eocene. Advanced Tarsioid Primate, *Microchœrus*.
VIII. Miocene. Primitive Anthropoid Primate, *Dryopithecus*.
IX. Pleistocene. Primitive Man, Mousterian.
X. Recent. Modern Man, White.

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THE DEVELOPMENT OF THE HUMAN FOOT AND ITS PHYLOGENETIC SIGNIFICANCE[1]

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The human foot is a structure peculiarly adapted to the erect posture, yet bearing convincing evidence of particularly significant evolutionary changes. An understanding of the past history of this organ of locomotion is therefore of the utmost importance.

Paleontology supplies concrete evidences of human evolution, but, unfortunately, the relatively delicate and small bones of the foot are not favorable for fossil preservation. Of ancient man, we know as yet only the foot skeleton of the Neanderthal race, and these remains are not as complete as would be desirable for a critical analysis. Concerning the posterior locomotor appendage of the progenitors of the modern apes and monkeys very little is known. Comparative anatomy and the allied comparative embryology supply in a great measure the gaps in the geological record. The Recapitulation Theory is no longer applicable in its original sweeping interpretation; it is, however, still of tremendous value in all phylogenetic investigations, contributing to either a hypothetical reconstruction of ancestors or merely pointing out evolutionary relationships through closely correlated developmental changes.

This study is devoted to the ontogenetic changes occurring in the skeleton of the human foot and of its physiological adjunct, the leg, with the intention of filling a definite gap in our knowledge of human growth, as well as of thus obtaining data for phylogenetic interpretation.[2]

The technique used in these investigations was chosen after due consideration of the problem at hand. For adult specimens the measurements adopted were those given by Martin in his "Lehrbuch der

[1]Preliminary report on investigations to be published in full in Contributions to Embryology, Carnegie Institution of Washington, volume for 1927.

[2]The material used in these investigations consisted of 50 white and negro fetuses ranging in age from 8 to 37 weeks (23 to 322 mm. crown-rump length); 4 newborns (2 whites and 2 negroes); 2 negro juveniles; 8 adult humans (4 whites and 4 negroes); and 49 anthropoid apes and monkeys (11 gorillas, 14 chimpanzees, 7 orang-utans, 10 gibbons, 7 howling monkeys). In addition, a number of other primate foot skeletons were examined for various points. The author wishes to thank Dr. G. L. Streeter, Carnegie Institution of Washington; Dr. L. H. Weed and Dr. A. H. Schultz of the Johns Hopkins Medical School; Dr. A. Hrdlička and Mr. G. S. Miller, Jr., of the United States National Museum; and Dr. W. K. Gregory and Mr. Carl Akeley of the American Museum of Natural History for the use of the above-mentioned material. A detailed account of the specimens will be given in the author's larger paper.

Anthropologie" (1914), pages 930–948 and 1040–1068. Slight alterations were made in some instances to suit the peculiar nature of the work. The larger specimens were dissected out, and in the cases of juvenile and younger stages, the skeletons were kept in a weak formalin solution when not in use. Dried fetal or infantile skeletons are absolutely useless and misleading for quantitative studies. In the earlier stages use was made of specimens stained with toluidin blue and cleared in 2% potassium hydroxide. The two youngest specimens were studied by means of enlarged plaster reconstructions made by the author after the Born-Lewis method.

Our knowledge of the development of the human foot is chiefly based upon the investigations of Henke and Reyher (1874), Leboucq (1882), Lazarus (1896), Schomburg (1900), Bardeen (1905), and Schultz (1923, 1924). Work on certain points of leg development have been done by Gegenbaur (1887), Retzius (1900), Brachet (1900), Le Damany (1909), Lustig (1915), and Nishizuka (1925). All of these papers are of limited scope, and a great many of the most interesting points of foot and leg ontogeny have up to this time been neglected.

In this paper only the summarized results of the author's investigations will be mentioned.

Leg

The tibia is always the longer and thicker of the two leg bones in man. In the eighth fetal week the greatest fibula length measures only 64 per cent. of the greatest tibia length, increasing to 77 per cent. in the ninth week and 94 per cent. during the fourth month, with a postnatal increase to 99 per cent. in adult man. In Alouatta (howling monkey) the fibula becomes relatively slightly shorter with growth. Alouatta,[3] Gorilla, and Symphalangus (siamang) all have relatively shorter fibulae than has adult man. In man the proximal end of the fibula shifts upward on the tibia during the course of growth, this change being most marked in the early developmental stages; in Alouatta a similar ontogenetic process seems to occur.

Gegenbaur (1887) states that as late as the fifth prenatal month the human fetus exhibits an internal malleolus which is longer than the external. The writer can verify this statement. The internal malleolus of the early human fetus generally projects further distally than does the external, this simian condition being most accentuated in the second and third fetal months; starting with the fourth month the external malleolus seems to grow faster than the internal, so that after

[3]The author has adopted Elliot's (1912) nomenclature for the primates.

the beginning of the fifth month the typically adult human condition, with dominant external malleolus, is most common. All other adult primates have the internal malleolus the longer. In the case of Alouatta its prominence is not so marked in fetus and newborn as in either juvenile or adult; this monkey thus exhibits a malleolar growth change in quite the opposite direction from man, the condition of the two forms in respect to this character being very similar in the fetus and highly divergent in the adult.

The epiphyses of the tibia in man are relatively much broader (in relation to the tibia length) in the fetus than they are postnatally. Both juvenile and adult Gorilla, as well as the Neanderthaloid tibia from Spy (see Wood, 1920) exhibit tibial epiphyses of about the same relative stoutness as those of fetal man from the third month to birth.

Retzius (1900) noted that the proximal epiphyses of the human tibia is markedly bent back (retroverted) during prenatal life. This early retroversion is due only in part to a bending back of the tibial head itself, the chief factor involved being retroflexion of the neck of the bone. It thus becomes necessary to distinguish between apparent retroversion and true retroversion, the latter being the difference between the former or ordinary "retroversion" (see Martin, 1914) and the angle of retroflexion. These relations are quantitatively expressed in Table 1. The tibia of adult Gorilla exhibits greater apparent retroversion and greater retroflexion than that of adult man, the true retroversion being negligible for both. Alouatta shows the same growth changes as man, that is, a decrease in both types of retroversion, but in the monkey both retroversion and retroflexion are always more marked.

Adult human fibulae are either straight or have their heads bent slightly forward. During fetal life this effect is reversed, the head of the fibula being bent back toward the ventrum of the leg. A fibula with retroverted head is always associated with great tibial retroversion or retroflexion.

The torsion of the tibia increases with growth in man, the greatest increase taking place postnatally. This twisting of the larger leg bone is intimately associated with the erect posture, and is much greater in adult man than in any other adult primate. The human values are: Fourth month fetus $+8°$, newborns $+11.8°$, juvenile $+17°$, and adults $+28.4°$. Unfortunately, no ontogenetic series of any other primate was available to the author for study in regard to this character.

Foot

A. TARSUS

The human talus undergoes important proportional changes during its growth. It becomes relatively both broader and higher with development. According to Volkov (1904), a low talus is typical of climbers, a high talus of walkers. The tali of the anthropoid apes are all relatively lower than that of adult man, particularly those of the two most arboreal, the orang-utan and the chimpanzee. It is of interest to note that the postnatal changes in talus proportions for Gorilla are analagous to those occurring in man, the bone becoming both relatively broader and higher with growth.

The fetal human talus shows a quite marked medial deviation of the neck from the long axis of the trochlea, decreasing from an average value of 33.4° in the fourth month fetuses to 22.1° in adult man. The fetal condition is quite simian, for all other adult primates exhibit a much greater medial deviation of the collum tali than does the adult human. Both Gorilla and Pongo (orang-utan) undergo similar changes postnatally. Averages for adult primates other than man are: Gorilla 32.2°, Pongo 32.4°, Pan (chimpanzee) 31.9°, Hylobates (gibbon) 31.3°, Symphalangus 30.8°, Lasiopyga (guenon) 28.0°, Ateleus (spider monkey) 52.0°, and Cebus (capuchin monkey) 40.0° (the last three quoted after Volkov).

The human fetus exhibits another simian character in the relatively slight amount of torsion of the talus head, which averages 17.8° in the fourth prenatal month, 25.9° for newborns, and 36.7° in adult life. This growth change, like the preceding, is closely associated with the ontogenetic adduction of the hallux and the loss of its opposability, and is thus of high phylogenetic signifiancce. The mean values of this angle for adult anthropoids (excepting orang-utan) correspond to the average for man during later fetal life. They are as follows: Pan 24.0°, Gorilla 22.5°, Symphalangus 22.0°, Hylobates 20.6°, (the average for Pongo is 8.8°).

The length-width and length-height indices for the calcaneus show no significant changes during human ontogeny. The calcanei of adult apes are all relatively narrower and slightly lower than that of man.

The sustentaculum tali of the human calcaneus is relatively much narrower than that of adult anthropoids, and this difference is accentuated in the human fetus; however, the maximum value of the sustentaculum index in prenatal man falls well within the range for adult apes.

The body of the calcaneus, when compared to the entire length of the bone, is proportionately longer in adult man than in any other primate, excepting Gorilla, in which the heel has undergone a remarkable hypertrophy, surpassing even that of man. In the human the relative length of the corpus calcanei increases from 50.7 per cent (of the entire length of the bone) in third month fetuses to 57.0 in newborns, and 72.0 in adults. In Gorilla the same change is apparent, at least postnatally, the average for juveniles being 69.9, for adults 77.7. This index for an Alouatta fetus fell well within the range for adult howlers, while for a newborn howler it was considerably less than in any other specimen, either fetal or adult.

Volkov (1904) associates a relatively short calcaneus with climbers and a long one with walkers. It is therefore of interest to note that while in human fetuses of the third month the greatest calcaneus length is only 25 per cent. of the greatest foot length, it has increased to 30 in the month preceding birth, and to 35 in adults. This change in relative calcaneus length is closely associated with the backward development of the heel (i. e., increased relative length of corpus calcanei, mentioned above). In Alouatta, there seems to be a decrease in relative calcaneus length, from 23.5 per cent. in a fetus 111 mm. CR. and 25.8 in a newborn to 21.7 in adults. Among the anthropoids, adult Hylobates (19.0) has a proportionally shorter calcaneus than even early fetal man, whereas in adult Gorilla (29.0) we find the closest approach to the mature human.

The tuber calcanei shows a slight ontogenetic increase in relative width, both in man and Gorilla, which, in adult life, have practically the same tuber width (in percentage of least calcaneus width).

In early human fetuses talus and calcaneus lie in approximately the same plane; the dorsal migration of the former element during subsequent growth produces a change in the relation of the two bones, roughly expressed by the talo-calcaneus angle (see Martin, 1914). In all primates, excepting man, this angle has a high positive value, indicating a medial inclination of the neck and head of the talus. With development, this angle for man undergoes considerable reduction, its mean in the earlier months (4th–8th) being closer to the average for adult anthropoids. Gorilla also undergoes a similar postnatal decrease in the size of the talo-calcaneus angle (see Table 2).

In fourth month fetuses the human talus is 89 per cent. as long and 95 per cent. as broad as the calcaneus, whereas in the adult the length has dropped to 69 per cent. and the width increased to 102 per cent.

It is interesting to find that the growth changes in Gorilla occur in the same direction as in man in both the above-mentioned proportions.

B. METATARSUS

The first metatarsal of the human foot is considerably thicker than that of any other toe, and this condition is also true for all of fetal life. In this respect man shows no essential difference from other primates, for Schultz (1924) reports the hallucial metatarsal as being the stoutest in fetuses of a number of monkeys. The writer could verify this in the case of Alouatta. Also, in both adult and juvenile anthropoids the first metatarsal is always thicker than the second, except in the orang, whose hallux has degenerated.

When metatarsus I is compared with metatarsus II, a marked ontogenetic increase in length of the former is apparent, both in man and Alouatta. Metatarsus V shows no length change during growth (in relation to metatarsus II) for either of these forms.

The great divergence of the big toe in human fetuses is a well-known fact. In the earlier prenatal life this divergence is associated with an increase in torsion of the hallucial metatarsal, and is thus indicative of a greater opposability, a distinctly arboreal condition (see Table 3). Gorilla undergoes a similar postnatal change in respect to this torsion.

C. PHALANGES

During the whole of human growth the basal phalanx of the great toe is considerably thicker than the corresponding element of the lateral digits, in this respect paralleling the condition found present among the metatarsals. There is little difference in the thickness of the four outer basal phalanges. That of the fifth toe does not show any degenerative tendency during ontogeny. Whereas in man the basal phalanx of the hallux becomes relatively stouter with growth, when compared to that phalanx in the lateral digits, in Gorilla and Alouatta this process is not so well marked.

Compared to the total phalangeal length, the basal phalanges of the lateral toes of man become relatively longer with growth, while the terminal phalanges are reduced, the middle retaining approximately the same proportional length. In Alouatta this developmental condition is reversed. These observations strongly suggest that, similar to the ontogenetic changes in man and monkey, there occurred phylogenetic ones, by which it was the terminal segment that was shortened in man, whereas lengthened in monkey.

D. INTERRELATIONS OF TARSUS, METATARSUS AND PHALANGES

The relative tarsus length of small human fetuses is somewhat less than in the adult, whereas, the relative phalangeal length behaves in just the opposite manner; the relative metatarsus length is quite constant throughout practically the whole of growth. In Alouatta, the reverse growth process takes place, the tarsus becoming shorter and the phalanges longer. A short tarsus and long phalangeal region is an arboreal primate characteristic. The feet of fetal man and fetal Alouatta are much more alike in regard to these relations than are those of the respective adult stages—i. e., during growth specialization occurs in divergent directions. This fact is well demonstrated in Table 4.

The striking relative increase in tarsus and decrease in phalangeal length during early human development, with the reverse process true for Alouatta, is further indicated by the tarso-phalangeal index (length of phalanges II x 100 divided by tarsus length), which in the former decreases from 122.1 in the eighth prenatal week to 62.4 in the third fetal month, 50.4 in newborns, and 47.4 in adults, while in the monkey it increases from 105.9 in the 111 mm. fetus to 114.2 in the newborn and 142.5 in adults.

In adult man the hallux is generally the longest toe, whereas in fetuses younger than seven months the great toe is, as a rule, shorter than the second. Table 5 shows the ontogenetic changes in proportions between the skeletal elements of the digits, demonstrating not only the striking reduction of the phalanges of the lateral toes during human growth, but also the gradual increase of the hallux to its dominant position. It will be noted that in man these growth changes go in a directly opposite manner from those in chimpanzee and howler, as has been previously demonstrated by Schultz (1924). The first column shows how the hallux in man grows faster than the second toe, while in ape and monkey its development is slower. The second column indicates that this growth change is accentuated in the phalangeal region. Column 3 shows that during development the phalanges of the lateral toes become relatively shorter in man and longer in the other primates.

Among the higher primates, excepting only man, the third toe is always the longest, the typical digital formula being 3⟩4⟩2⟩5⟩1, with 3⟩2⟩4⟩5⟩1 as an occasional variant. In man the great toe has become greatly strengthened and lengthened, so that the usual adult formula is 1⟩2⟩3⟩4⟩5, although 2⟩1⟩3⟩4⟩5 is by no means infrequent. Occasional instances are on record in which the third toe is the longest of all, and

this must be regarded as the retention of a primitive primate condition. The first toe, as previously demonstrated, does not attain its characteristic adult dominance in man until late in fetal life; human fetuses commonly exhibit digital formulae of 2⟩1⟩3⟩4⟩5 and 2⟩3⟩1⟩4⟩5, although in the earliest fetal stages the third toe may occasionally be longer than both the first and second. Schultz (1924) has pointed out that in the development of other primates the digital formula does not change as it does in man but is apparently quite constant and uniform. A small ontogenetic series of Alouatta examined by the writer confirms Schultz' statement in regard to this particular genus. The metatarsal formula in man, like the digital, changes during growth. In the adult the head of the second metatarsus is furthest from the heel, the formula reading 2⟩3⟩4⟩5⟩1. This is also the typical arrangement for juveniles, newborns, and fetuses of the 9th, 8th, 7th and 6th lunar months, although variants of 2⟩3⟩1⟩4⟩5 are occasionally encountered. For the 5th and 4th months 2⟩3⟩1⟩4⟩5 is the rule. Earlier than this a metatarsal formula of 3⟩2⟩1⟩4⟩5 or 3⟩2⟩4⟩5⟩1 is most common. A comparison of the digital and metatarsal formulae during growth will show that the changes in the former are brought about chiefly by the reduction of the lateral phalanges.

E. FOOT LEVERAGE

All primates possess a transverse foot arch, but the longitudinal arch is the peculiar property of man. Its development has been a distinct aid in the attainment of the erect posture, buttressing the entire foot skeleton and producing a favorable arrangement for the support of the great weight. A definite longitudinal, as well as a transverse arch, is plainly evident in the human newborn, and also in fetuses. The evolution of the longitudinal arch has increased the leverage of the human foot. Thus man possesses a much greater foot leverage than any other primate, excepting Gorilla, in which the upper limit of variation for the leverage index overlaps the lower range in adult man. During human ontogeny the leverage of the foot undergoes a steady increase, a growth change of phylogenetic significance.[4] Other primates exhibit no great change in this respect, at least not postnatally. The growth changes in man and Alouatta and the condition in other primates is expressed in Table 6.

[4]The index of foot leverage as herein expressed is obtained by multiplying the projective distance from the middle of the trochlea tali to the tuber calcanei by 100 and then dividing by the projective distance from the tuber calcanei to metatrsophalangeal joint II. This index expresses the value of the power arm of the foot lever in percentage of the physiological foot length.

F. FOOT INDEX

The length-width index of the foot undergoes considerable change during human ontogeny, the fetal foot being considerably broader than that of the adult (also see Schultz, 1923). Values for this index are 83.3 for an eighth week fetus, 41.0 for the third fetal month, 33.3 for newborns, and 32.8 for adults. Alouatta also exhibits this great ontogenetic reduction in relative foot width, from 75.7 in a 21 mm. fetus to 33.2 in a newborn and 25.9 in adults. Man has the relatively broadest foot among the higher primates. It seems likely that this ontogenetic narrowing of the pes is a growth process common to at least all the higher members of the order, man in this respect being the least highly specialized.

Interrelations of Foot and Leg

The leg-foot length index of adult man is lower than that of any of the other primates concerning which data is available. Throughout all of fetal life this index for man is higher than in adult life. For an eighth week fetus it has a value of 141.3, falling to 80.9 in the fifth and sixth prenatal months, from which point it rises to an average of 90.3 at birth, again falling to 64.6 in adult life. Similar changes during growth are noted in Gorilla, Pongo, Colobus (guereza monkey), Alouatta, and Tarsius (spectral tarsier), but in none of these forms does the relative foot length undergo as great a final reduction as in man.

As late as the seventh prenatal month the feet of the human fetus are turned inward, so that the soles face each other and stand parallel to the mid-sagittal plane of the body. During subsequent development a rotation of the foot occurs, until the soles of the feet face downward. The supinated position of the fetal foot cannot be ascribed to intra-uterine pressure, as some writers have claimed, but can only represent the recapitulation of an ancestral condition. The feet of all adult primates, with the exception of man, exhibit this supination in a most marked manner, the soles facing each other in varying degrees. This condition is correlated with arboreal life, being a characteristic of a grasping foot. As man attained the erect posture there must have occurred a shifting of the pes, the tarsus being rotated from the fibular to the tibial side of the leg, so that the sole could be firmly applied to the ground. In a fully pronated foot the axis of the tuber calcanei is parallel with that of the diaphysis of the tibia. Whenever pronation is incomplete the two axes form a determinable angle, which is known as "the angle of torsion of the calcaneus," and which roughly corresponds

to the degree of supination. This angle was measured upon specimens with soft parts intact except for the heel and the ventrum of the leg. Such a procedure exposes tibia and tuber calcanei, permitting the only reliable determination of the true, natural angle. With advance in growth, the human tuber undergoes a rotation, so that the torsion of the calcaneus exhibits a marked ontogenetic reduction, having an average value of 36.8° for third month fetuses, 28.3° for fourth month fetuses, 22.4° for newborns, and only 3.5° for adults. In the howler, Alouatta, the reverse growth process occurs, a fetus 111 mm. CR. having a torsion of 23.5°, a newborn 26.5°, with the average for adults being 36.8°; in this genus the ontogenetic rotation of the tuber is in an opposite direction from that occurring in man, so that the foot is more supinated in adult monkey than in fetus or newborn.

Conclusions

The easily recognizable structural resemblance of the fetal foot and leg of man to those of adult arboreal primates, with the subsequent loss of primitive characteristics in the attainment of the distinctly human condition, suggests strongly that here we see in the main a recapitulation of ancestral conditions. No other logical explanation can, at the present time, be offered for the many simian characters found in utero. Also, the fact that the feet of man and other primates are much more alike in early stages of development than they are later in life, most of their adult differences being produced through divergent growth, points strongly to a basal type of foot from which the variously specialized feet of all the primates developed phylogenetically as well as ontogenetically. This last theory should, by nature of the evidence now at hand, be restricted to the monkeys, apes, and man, in that the ontogeny of the foot in the Lemuroidea and Tarsioidea is at the present time entirely unknown.

TABLE 1.

Changes in Apparent Retroversion, Retroflexion, and True Retroversion of Tibia During Growth of Man, Gorilla, and Howling Monkey.

		Apparent Retroversion	Retroflexion	True Retroversion
Man	Fetus, 8th week	20.5°	16.0°	4.5°
	Fetus, 3rd month	31.5°	19.8°	11.7°
	Fetus, 9th month	31.1°	12.4°	17.6°
	Adult	13.3°	12.3°	1.1°
Gorilla	Juvenile	25.0°	22.0°	3.0°
	Adult	25.0°	23.5°	1.5°
Alouatta	Fetus, 111 mm. CR.	49.0°	24.5°	24.5°
	Newborn	40.0°	15.0°	25.0°
	Juvenile	24.0°	14.0°	10.0°
	Adult	28.5°	16.8°	11.7°

TABLE 2.

Talo-Calcaneous Angle During Human Growth and in Anthropoid Apes

Man	Fetus, 4th month	+ 9.0°
	Newborn	+ 3.3°
	Adult	+ 1.6°
Anthropoid Apes	Gorilla, juvenile	+20.5°
	Gorilla, adult	+16.8°
	Hylobates, adult	+16.7°
	Pongo, adult	+12.4°
	Pan, adult	+12.4°

TABLE 3.

Hallucial Divergence (Angle Between Long Axes of Metatarsi I and II) and Torsion of Metatarsus I During Human Ontogeny

		Hallucial divergence	Metatarsus I torsion
Man	Fetus, 8th week	32.0°	
	Fetus, 4th month	11.1°	+25.1° (+22.0°–+26.5°)
	Newborn	5.8°	+14.1° (+13.5°–+15.0°)
	Adult	6.2°	+12.8° (+ 7.0°–+19.0°)

TABLE 4.

Lengths of Tarsus, Metatarsus, and Phalanges Expressed in Percentages of Total Length of These Segments Through the Second Toe (Tarsus + Metatarsus II + Phalanges II) During Growth of Man and Howling Monkey.

		Tarsus	Metatarsus	Phalanges
Man	Fetus, 8th week	28.6	36.5	34.9
	Fetus, 3rd month	42.9	30.7	26.4
	Newborn	45.7	31.2	23.1
	Adult	46.9	31.0	22.1
Alouatta	Fetus, 111 mm. CR.	33.5	31.1	35.4
	Newborn	33.5	28.3	38.2
	Adult	29.6	28.3	42.1

TABLE 5.

Changes in Proportions Between Skeletal Elements of First and Second Toes During Growth of Man, Chimpanzee, and Howling Monkey. The Figures for Newborn and Juvenile Chimpanzee and for the 30 mm. Alouatta Fetus are After Schlutz (1924), Those for Adult Chimpanzee After Schwalbe (1917).

		$\frac{\text{Ray I}}{\text{Ray II}} \times 100$	$\frac{\text{Phalanges I}}{\text{Phalanges II}} \times 100$	$\frac{\text{Phalanges II}}{\text{Metatarsus II}} \times 100$
Man	Fetus, 3rd month	75.4	76.6	85.9
	Fetus, 5th and 6th months	84.6	87.9	78.0
	Newborn	95.5	108.3	74.1
	Adult	95.3	112.4	71.7
Pan	Newborn	80.9	86.1	93.5
	Juvenile	67.0	64.6	104.3
	Adult	66.3	56.0	126.3
Alouatta	Fetus, 30 mm. CR.	71.0	68.0	81.0
	Fetus, 111 mm. CR.	61.6	59.3	113.7
	Newborn	64.8	55.4	135.2
	Adult	61.6	53.9	149.2

TABLE 6.

THE FOOT-LEVERAGE INDEX DURING THE GROWTH OF MAN AND HOWLING MONKEY AND IN ANTHROPOID APES.

Man	Fetus, 3rd month	14.9 (12.8–17.6)
	Fetus, 7th and 8th months	16.2 (13.8–18.2)
	Newborn	17.9 (17.6–18.4)
	Adult	25.5 (22.0–28.6)
Anthropoid Apes	Gorilla, juvenile	21.6 (17.4–25.8)
	Gorilla, adult	20.8 (17.1–25.0)
	Pan, juvenile	20.9 (17.4–24.4)
	Pan, adult	18.2 (16.4–19.6)
	Pongo, adult	16.8 (14.0–18.8)
	Symphalangus, adult	15.3 (12.5–18.1)
	Hylobates, adult	14.6 (13.4–15.7)
Alouatta	Fetus, 111 mm. CR	18.8
	Newborn	18.8
	Adult	17.0 (15.6–18.7)

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THE ATLAS IN WHITES AND NEGROES

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An inquiry in respect to variability in races, chiefly in Whites and Negroes has been carried on in this laboratory for a number of years. One of the questions, the response in tendency to vary, has been studied by Terry,[1] Thomspon, Batts and Danforth,[2] and by Trotter.[3] The present investigation of the atlas is in further pursuit of knowledge on this question.

The atlas in lower mammals is a robust bone. Its cephalo-caudal extent as a rule exceeds the dorso-ventral diameter. The posterior arch is perforated by a definite foramen for transmission of the vertebral artery and first cervical nerve, and the arch as a whole is well developed. The transverse processses are large and permit of the attachment of strong muscles.

The first vertebra of man is rather an atypical atlas. It is not at all massive; its height (cephalo-caudal extent) is far less than its antero-posterior (dorso-ventral) diameter; the vertebral artery and first cervical nerve traverse a notch in the posterior arch; the arch is slender and in some cases incomplete; the transverse processes are relatively small in adaptation to the attachment of rather weak muscles. The differences between the human atlas and the atlas of lower mammals have led to the conclusion that the atlas in man is undergoing regression. Other evidence of regression than those just cited are seen in the tendency of many of its variations (Allen,[4] Macalister[5]), in its development (Terry[6]) and in the occurrence of synostosis with the epistropheus and assimilation with the occipital bone (Dixon,[7] Swjetschnikow,[8] Weigner[9]). Bolk[10]

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has put forward evidence supporting the view that not only the atlas but the whole segment of which it is a part is undergoing regression in man. The inspection of only a few atlases reveals a very varied morphology. Since the variations in question are not the result of environmental influences such as occupation or posture, a study of this bone lends an index to hereditary tendencies and a correlation of the variations with race leads to an insight into inherent racial differences.

The material for the present comparisons consisted of specimens from the collection in the Department of Anatomy, Washington University, derived from cadavers of recorded race, sex and age; and some negro atlases, sexed, from the United States National Museum. The age range was 27 to 80 years with an average of 45 years. The bones were free from evidences of disease and gross deformity. There were 102 atlases of Whites and 81 of Negroes.

This series of atlases was examined for:

I. Variations of (1) groove for vertebral artery, (2) costal process, (3) posterior arch, and (4) relative height.

II. The comparative incidence of these variations in negroes and whites.

GROOVE FOR VERTEBRAL ARTERY

The groove in the posterior arch which lodges the vertebral artery and first cervical nerve was found to vary from a simple groove to a complete foramen. The intermediate conditions were classified as "tubercle" when only a small but definite postglenoid tubercle was present just below the posterior border of the superior articular process; and as "process" when a definite spicule of bone projected posteriorly from the same location or anteriorly from the posterior margin of the groove in such a manner as to convert the groove into an incomplete foramen. Table 1 shows the distribution of simple groove, tubercle, process and complete foramen.

TABLE 1.

	Negro			White		
	Males	Females	Total	Males	Females	Total
Number classified	66	15	81	86	16	102
Simple groove	14	4	18 (22%)	27	6	33 (32%)
Tubercle	28	4	32 (40%)	40	6	46 (45%)
Process	17	4	21 (26%)	8	3	11 (11%)
Complete foramen	7	3	10 (12%)	11	1	12 (12%)

The incidence of a complete foramen is the same in both races but an incomplete foramen as formed by processes has a greater incidence in negroes, whereas the simple groove is found more frequently in whites. The negro has therefore a greater tendency toward the foramen and

the white a greater tendency toward a simple groove. A complete foramen, it will be recalled is the rule in lower mammals.

COSTAL PROCESS

It will be recalled that the costal process, which limits the costo-transverse foramen anteriorly, corresponds to the head and neck of a rib, and that the transverse element posterior to the foramen corresponds to the transverse process of a thoracic vertebra.

Variations from the normal costal process which is as large or larger than the transverse process and which is completely ossified fall logically into two groups: (1) Rudimentary; those in which the costal process is completely ossified but definitely smaller than the transverse element, and (2) Incomplete: those in which the costal process in addition to being much smaller is incompletely ossified. Table 2 shows the distribution of the two groups.

TABLE 2.

	Negro			White		
	Males	Females	Total	Males	Females	Total
Number classified.......	66	15	81	86	16	102
I. Rudimentary.......	7	1	8 (10%)	17	2	19 (19%)
II. Incomplete........	4	1	5 (6%)	8	1	9 (9%)

This variation in development as indicated both by a rudimentary and an incomplete condition has a greater incidence in whites than in negroes, the total in whites being 28% as compared with 16% in negroes.

POSTERIOR ARCH

Five instances of an incomplete posterior arch were noted in the 183 atlases. The incompleteness was shown by a failure of the two lateral halves of the arch to unite in the mid-line. Table 3 shows the distribution of these instances.

TABLE 3.

	Negro			White		
	Males	Females	Total	Males	Females	Total
Number of specimens....	66	15	81	86	16	102
Incomplete arch........	0	1	1 (1%)	2	2	4 (4%)

The defect was present in so few instances that one is hardly justified in arriving at a conclusion as to its incidence in the two races; but it is interesting to note that there is a higher figure for whites than for negroes.

RELATIVE HEIGHT

Each atlas was measured with a Hrdlička large sliding compass to determine the greatest height and the greatest antero-posterior diameter. Antero-posterior diameter was measured by placing the compass on a smooth table and allowing the bone to rest on its superior articular processes between the jaws of the instrument. The atlas placed in this position has the arches in a plane parallel to the surface of the measuring table. Greatest height was measured with the compass in the same position by placing the atlas, anterior arch downward, with the superior articular processes firmly against the fixed jaw of the instrument. This measurement is therefore at right angles with the previously determined antero-posterior diameter. Greatest height and antero-posterior diameter were determined with a view of obtaining an index to relative height. The following formula was used:

$$\text{Relative height index} = \frac{\text{Height x 100}}{\text{Antero-posterior diameter}}$$

The average for negroes and the average for whites was determined. the extreme variations from these averages, and curves of distribution made to show the percentage of specimens having any one index.

Average relative height index, Negroes, 48; Whites, 49.

Extremes: Negroes, 37 and 57; Whites, 38 and 64.

Distribution of the indices from 37 to 64 inclusive is shown in Figure 1.

The mode is the same in both races but there is a slightly wider distribution in whites.

SUMMARY

It was found in the series of atlases examined that the tendency was greater in Whites than in Negroes (1) to vary from the mammalian type with a foramen in the posterior arch; (2) toward the less complete fusion of the costal process; (3) toward incompleteness of the posterior arch. (4) The relative height indices were distributed over a slightly wider range in Whites than in Negroes.

CONCLUSION

This comparison of samples of the atlas shows a tendency of the variation studied toward (a) greater frequency of the four variations in Whites than in Negroes, (b) regression in the atlas more marked in that of the White, (c) greater departure from the mammalian type in the White than in the Negro.

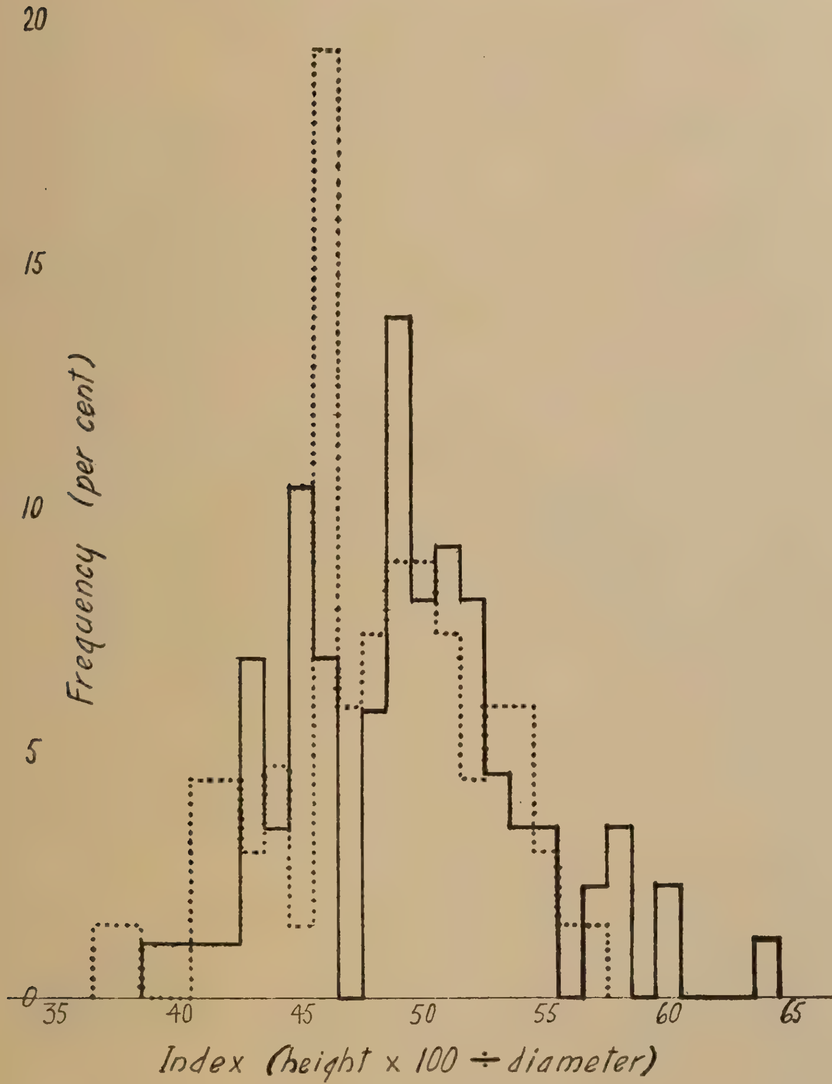

Fig. I. Distribution of relative height indices
······ negroes
—— whites

THE SACRUM AND SEX

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INTRODUCTION

This research was done in the University Museum at Oxford during the winter of 1925–26. I am very much indebted to Professor Thomson for putting the facilities of his department at my disposal and for his kind supervision of the work; also to Mr. Buxton for his keen interest and useful suggestions.

The material on which this study is based is a part of the large Egyptian collection which is in the Museum. A detailed description of the cranial part of the collection may be found in *The Ancient Races of the Thebaid* by Thomson and MacIver. A study of the movable segments of the vertebral columns of these Egyptian skeletons is included in another communication to this JOURNAL. (See page 457 of this number.)

The present study is the result of an attempt to distinguish the sex of previously unidentified sacra. The greater number of skeletons in this series have been sexed on archaeological as well as anatomical grounds, but a few unmarked sacra brought to attention the fact that sex differences in the sacra of this group at least were not as distinct as had been supposed previously. Thus, this part of the investigation has resolved itself into a study of the sacrum from the standpoint of sex.

MATERIAL

TABLE 1.[1]

CLASSIFICATION OF THE SACRA ACCORDING TO SEX AND COMPOSITION

Sex	5 Vertebrae	6 Vertebrae	4 Vertebrae
Male (46)	37	4	5
Female (44)	38	2	4
Undetermined (26)	21	1	4
Total (116)	96	7	13

The sacra of undetermined sex were discarded. Only those identified sacra which are normal or composed of five vertebrae were measured, thus limiting the useful number of specimens to 75. However, in no case may one expect to find a complete set of measurements, for in spite of the comparatively excellent condition of these very old skeletons, an occasional bone was fragmentary. The variations from the usual

[1]The numbers in brackets in Table 1 and in succeeding tables indicate the total number of specimens examined.

5-vertebrae form are not in accord proportionally with most reports. The general tendency is said to be toward lengthening rather than shortening of the bone, while in this group the lengthened form presents itself in only about half as many cases (6.0%) as the shortened form (11.2%).

MEASUREMENTS

The following measurements were taken:—

1. Mid-ventral straight length (length of sacral axis); the length of the straight line drawn from the median point in the anterior or margin of the promontorium to that of the apex. Sliding compass.
2. Anterior straight breadth; the length of the straight line drawn perpendicular to (1) across the ventral surface of the first sacral vertebra between the widest points of the margins of the lateral wings. Sliding compass.
3. Greatest straight breadth; the greatest straight breadth wherever it may be. Osteometric box.
4. Median longitudinal curve; a narrow strip of lead gently moulded to the bone along the ventral surface from the median point in the anterior or margin of the promontorium to that of the apex.

INDEX

Sir William Turner in his *Challenger Reports*, which include investigations of many more skeletons than those actually collected by the expedition, concludes that the proportion of the length to the breadth of the sacrum varies in the two sexes as well as in different races of mankind. He expressed these variations numerically by means of a sacral index which he determined by this formula:—

$$\frac{\text{Greatest straight breadth} \times 100}{\text{straight length}}$$

Those with an index below 100 he terms dolichohieric while those above 100 are platyhieric. This group has been further divided into a sub-platyhieric type with an index of 100–106 and platyhieric including all indices over 106. Turner classifies a list of twenty different peoples but unfortunately he does not include Egyptians.

Paterson in 1893 at St. Andrew's University presented figures from the sacra of 11 Ancient Egyptians, whose sex is undetermined. These were of skeletons presented to the Royal College of Surgeons of England by Sir William Flinders Petrie. Of this group only two have indices below 100, while the others vary to as high as 127.9. Paterson suggests that the Egyptians might be included as a platyhieric race.

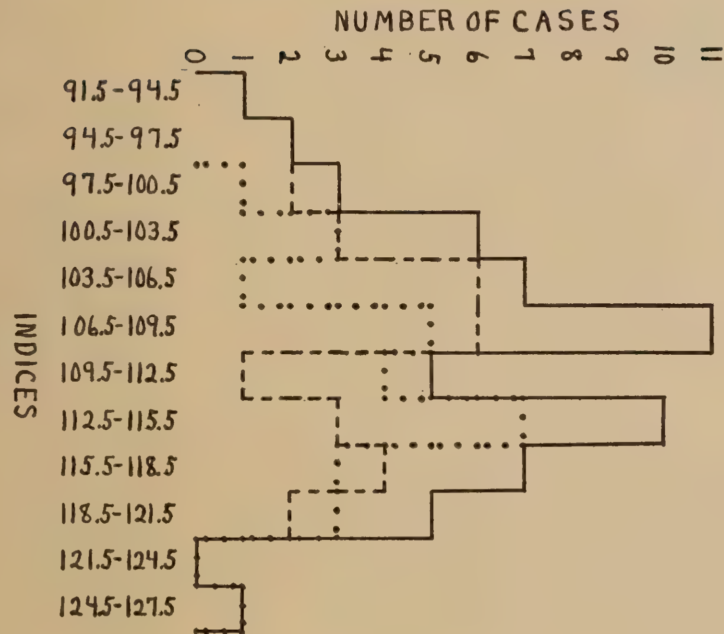

FIGURE I

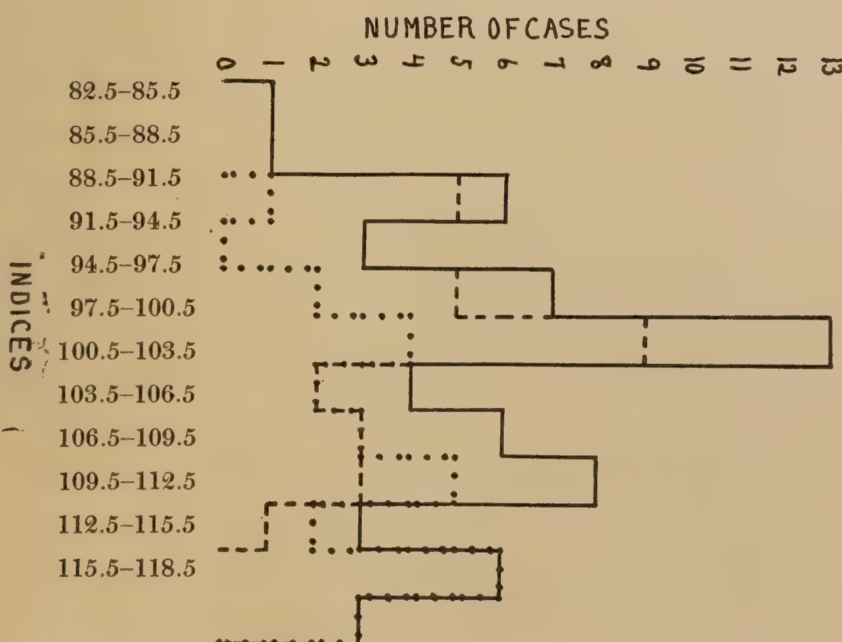

FIGURE II

FIGS. I and II. Diagrams showing the extent and variation of the indices. The broken line indicates the male group; the dotted line the female group; and the solid line the combined groups.

Figure I presents those indices when the greatest breadth was used; Figure II when the projected breadth was used.

Warren has reported on a larger series of Ancient Egyptian skeletons also excavated by Professor Petrie. In this group there were 77 sacra of known sex; 32 male and 45 female. The average index of the male group was 115 and of the female 113, presenting the anomalous result of the male sacrum being relatively broader than the female.

I determined the sacral index in two ways: first following Turner's scheme of using the greatest breadth of the base and secondly by using the projected breadth or the distance between the widest points on the ventral surface of the first sacral vertebra. This latter method gave slightly better results. Since previous reporters have used the former method both sets of results will be presented.

TABLE 2.
AVERAGE INDICES IN MILLIMETRES

	Sex	Mean	Probable error	Standard deviation	Probable error	Coefficient of variation	Probable error
G.B. × 100 / Length	Male (30)..........	107.7	±.87	7.0	±.61	6.5	±.51
	Female (28)........	112.1	±.82	6.5	±.58	5.8	±.52
P.B. × 100 / Length	Male (33)..........	97.9	±.78	6.6	±.55	6.8	±.57
	Female (28)........	107.0	±.88	6.9	±.62	6.5	±.58

By using the projected length in determining the indices the male group comes under the classification of dolichohiericy while the female group signifies platyhiericy. The indices when the greatest breadth was used place both the sexes in the platyhieric group. The large standard deviations and coefficients of variation bring into evidence the great overlapping of the two sexes (Figs. I and II).

This wide variation is not peculiar to the Egyptian sacra only. Wetzel reported in 1914 on a series of Australian sacra. He found a similar wide variation and concludes by grouping the bones under three types: (1) a pronounced dolichohieric group (which is in accord with Turner's classification); (2) a small platyhieric or subplatyhieric group; and (3) a small group of the six-vertebrae form.

ARTICULAR SURFACE

A most interesting suggestion for determining sex is that made by Derry, whose very wide experience of Egypt makes his work of great importance in this connection. He found the determining factor to be a difference in the shape and extent of the iliac articular surface: in the female it is smaller and extends in most cases over only two vertebrae, while in the male it almost invariably includes a part (and sometimes all)

of the third. In cases where the original line of junction was obliterated, he employed the lower border of the second posterior sacral foramen as indicating the lowest edge of the second sacral vertebra. It was necessary for me to depend almost entirely upon this method.

TABLE 3.
EXTENT OF ARTICULAR SURFACE

Sex	Articular surfaces covering: Less than 2	From 2 to 3	3 or more vertebrae
Male (37)	7	28	2
Female (37)	7	25	5
Total (74)	14	53	7

FIGURE III.

FIG. III. Superimposed composite curves of the sacra; the solid line indicates the male group and the broken line the female group.

Such a rule may not be applied to these old Egyptian bones for the summary in Table 3 shows the close agreement between the sexes. Certainly a variation of only three sacra is too small to matter; but if it might be considered a difference, the difference is in exact opposition to Derry's results.

CURVE

The unexpected result of the male sacrum being relatively broader than the female found by Warren in his series of Ancient Egyptian sacra he attributed "to the great curvature which many of the male sacra exhibited, while a considerable number of female sacra were nearly flat. Such a curvature will reduce the 'straight length' very appreciably and so the sacral index will become high."

Paterson, examining material of known sex at Dublin, found only slight differences in the curve between the sexes. In both cases the greatest depth of the curve was opposite the third vertebra of the sacrum; with the variation being more often below the third than above it. The curve varied irrespectively of the length of the bone. The sacrum was more often deeply curved in the upper part in the female than in the male, on the other hand the absolute depth was greater in the male than in the female. This point is of particular interest for comparison with composite curves I was able to make of the two sexes of the Egyptian sacra.

The various curves were recorded according to the scheme devised by Paterson of using the narrow strip of lead, moulding it along the median longitudinal plane of the bone and then from it transferring to paper

an outline of the curves. These outlines were traced on thin paper, superimposing them in a male and female group. The greatest depth of curve was almost invariably opposite the third vertebra. In this superimposed arrangement no differences between the sexes could be detected, only a wide variation of about equal amounts on the part of both. A composite curve of each sex was constructed by taking the average distance from a horizontal at 10 mm. intervals against which the extremities of the curve were placed. These two reconstructed curves were superimposed (Fig. III) and the results correspond exactly to Paterson's deductions which I referred to above. The actual depth is greater in the male sacra than in the female and flatter in the upper part, but the differences are so slight that they are of no aid in sexing a sacrum.

CONCLUSIONS

1. The average index of the male sacra is 107.7 and of the female 112.1, when the greatest breadth of the bone was used in the determination. There is wide variation present in both sexes.

2. The extent of the articular surface showed no sexual differentiation.

3. The average curves showed a slightly greater depth in the male than in the female as well as a greater tendency to flatness in the upper part.

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ASYMMETRY OF VERTEBRAL ARTICULAR PROCESSES AND FACETS

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The finding of asymmetry of the articular processes and facets of the eleventh and twelfth thoracic vertebrae in two of the skeletons of the anthropological collection at Washington University led to the review of all available material with the object of determining the incidence and possibly, relations of this condition.

This abnormality was reported by Struthers[1] in 1875 as one of the many variations which may occur in the transition region between the thoracic and lumbar spines. Barclay Smith[2] in 1902, described a twelfth thoracic vertebra with asymmetrical twelfth superior facets, the right being of the normal thoracic type, flattened and directed posteriorly, the left being typically lumbar, deeply concave and directed medially. He briefly mentions four other examples with exactly the same appearance and concludes that the condition is very rare. Later, in 1911,[3] while reporting a case of multiple anomalies of the vertebral column, Barclay Smith again mentions the asymmetry of the articular processes of the eleventh and twelfth dorsal vertebrae; but this time he says that "the lack of symmetry of the opposed facets is not an uncommon condition," and that "usually the flat facet is on the right side." LeDouble[4] (1912) reports such a condition in the last thoracic vertebra of a horse.

The material used for the present study, shown in Table 1, consists of spines prepared from the cadavers dissected in the anatomical laboratory, the race, sex and age of which are of record.

TABLE 1.

Race	Males	Females	Totals
White	139	20	159
Negro	69	19	88
Totals	208	39	247

The ages extend from 8 years to 82 years; 9 of the spines are from individuals of 20 years and less; 62 spines are of the decade 51–60 years, and this period is evidently the mode; 42 are 71 years and older.

[1]Struthers, John. On variations of the vertebrae in man. *J. Anat. & Physiol.*, 1875, IX, 2–96.
[2]Smith, Barclay. Two rare vertebral anomalies. *J. Anat. & Physiol.*, 1902, XXXIX, 372.
[3]Smith, Barclay. Multiple Anomalies in a Vertebral Column. *J. Anat. & Physiol.*, 1911, XIV, 144–147.
[4]LeDouble. Traité des variations de la colonne vertébrale de l'homme et de leur signification au point de vue de l'anthropologie zoologique. Paris, 1912.

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Four of the spines, as a whole, show a mild osteo-arthritis. One spine presenting the asymmetry of the articular processes occurs in a case of cleido-cranial dysostosis[5] in which there is scoliosis; the other spines in the series present no pathological changes.

In this series of spines thirteen show asymmetry of the articular processes and surfaces: the distribution of the variation is recorded in Table 2.

TABLE 2.

No.	Race	Sex	Age	No.	Race	Sex	Age
55	White	Male	50	198	White	Male	49
56	White	Male	50	205	Negro	Male	42
64	White	Male	30–40	244	Negro	Male	60
81	White	Male	46	272	Negro	Female	49
168	White	Male	72	M.317	White	Female	75
171	Negro	Male	70	M.318	White	Male	40
197	White	Male	53				

Two distinct types of the variation were found, one the mirror image of the other. In all cases with the exception of No. 244 and M. 318 the general scheme is as follows (Fig. 1): The superior articular processes of the eleventh thoracic vertebra are symmetrical and show the usual characteristics of the thoracic region; the inferior facets are asymmetrical, the left one being thoracic in type, flat, and directed anteriorly; the one on the right is lumbar in type, convex and directed laterally. The upper processes and facets of the twelfth correspond to the lower facets of the eleventh; i. e., the left facet is flat and directed posteriorly, the right is concave and directed medially. The lower facets of the twelfth are normal, that is typically lumbar in appearance and symmetrical.

In No. 244 (Fig. 2), the asymmetry is the reverse of that described above. In No. M.318, the asymmetry is like that of No. 244, but it occurs between the last thoracic and the first lumbar vertebrae. This first lumbar vertebra has a costal facet on the right articulating with a thirteenth rib, but none on the left. The right superior articular process is thoracic in character, the left is lumbar. The sacrum (five segments) and coccyx (four segments) are regular.

In regard to the frequency of the variation the figures drawn from the samples of our small series are here recorded as possibly showing the tendencies but with no claim of their being accurate for a large collection of spines. It apppears that the variation is present in somewhat more than 5 per cent (5.66) of the Whites examined and in somewhat more than 4 per cent (4.54) of the Negroes. Again, in white males the

[5]Terry, R. J. Rudimentary Clavicles and other Abnormalities of the Skeleton of a White Woman. *J. Anat. & Physiol.*, 1899, XXXIII, 413–422.

percentage (5.75) is higher than in black males (4.34). More data for these comparisons of the variation are much to be desired for determining the status of variability in different races.

The level at which the asymmetry of the articular processes was found is one of the three at which changes in the form of the vertebrae occur and where there is a change in the type of motion allowed between the vertebrae. At C_2–T_1 there is a change from a rather free movement in all directions to limited movements, chiefly of rotation, flexion and extension; at T_{12}–L_1 the change is from rotation chiefly to movements which are largely flexion and extension; and at L_5–S_1 the change is from angular motion to fixation. The limitation of movement between adjoining vertebrae is effected largely by the form and direction of the facets, by the ligaments and by the thinness of the intervertebral discs.

At the junction of the lumbar and thoracic segments symmetrical variations in the types of facets have been frequently noted. Struthers,[6] Ward,[7] LeDouble[8] and others have remarked the inconstancy of the level at which the change from dorsal to lumbar type of articulation occurs; and they have also noted that the change from one type to the other is often a gradual process extending over three or four vertebrae, rather than a precise and complete change in passing from one vertebra to the next. Asymmetrical variations are less frequently noted. In the literature no record could be found of asymmetrical articular facets, excepting pathological cases, occurring in any region other than the thoraco-lumbar transition zone; and in the present series of cases the asymmetry was limited to that region.

Scoliosis of any etiology is accompanied by asymmetry of the skeleton with definite changes in the vertebrae—rotation of the body of the vertebra to the convexity of the curve, lessening of the vertical depth of the body on the convexity of the curve, and, in the more advanced cases, a deepening of the articular facets in the convexity of the curve. The asymmetry of articulations in the present series, might then be a response to scoliosis. The skeleton of the dwarf with cleido-cranial dysostosis was the only one which showed any marked scoliosis. In this case the lumbar type of facet is on the left—the convexity of the curve where all the facets are somewhat deepened. However, the whole left side of the vertebra in question is lumbar in type, a condition not usually seen in scoliotic spines. Other examples of scoliotic spines, dried specimens from the pathological museum, were examined, but

[6]Struthers. *Loc. cit.*
[7]Ward. Osteology. London. 1876.
[8]LeDouble. *Loc. cit.*

none of these showed any vertebra with a lumbar type of facet on one side and a thoracic type of facet on the other.

There has been described a "normal" scoliosis which, according to numerous observers, is to be found in almost every individual. If there were any relation between asymmetry of the articular processes and the "normal" scoliosis one would expect to find the incidence of the variation higher than 13 out of 247.

A well known cause of asymmetry of the skeleton is that difference in stress which attends the unequal use of the right and left hands. It has been shown, in respect to the arms that in a right handed individual the bones of the right side are longer and sturdier, and the areas of muscular attachment are more marked. The clavicle of the right side is thicker, shorter and may show slightly greater curvature. In the spine, according to Gaupp,[9] the "normal" scoliosis of the thoracic region is toward the left in left-handed individuals. Regarding the skull, Elliott Smith[10] has shown that this also presents a definite asymmetry—the prominence of the occipital pole of the cerebrum on the left in a right-handed individual leaves a deeper impression, the fossa striata, on the skull than the less prominent pole on the right; and it is well known that the superior sagittal sinus, and its corresponding groove, is commonly deviated to the right. There is a reversal of these markings in left-handed individuals. Moorehead[11] (1902) in reviewing the work of Harting, Bischoff, Gaupp, and Thiele, adds some observations of his own on the symmetry of the body of the newborn child. He comes to the conclusion that the asymmetry is a feature which is developed in later life in response to the difference of muscular stress.

Measurements were made of the arm bones and of the clavicles of the present series, and the measurements of the right and left side compared. The skulls were studied for those signs of right and left-handedness which have been mentioned. It was found by the evidence of the limb and cranial criteria that twelve of the series were right-handed skeletons; of these, eleven possessed the flat facet on the left, one presented the flat facet on the right side. The thirteenth skeleton

[9]Gaupp. Die normalen Asymmetrien des menschlichen Korpers. Jena. 1902.

[10]Smith, G. Elliott. On asymmetry of the caudal poles of the cerebral hemispheres and its influence on the occipital bone. *Anat. Anz.*, 1907, XXX, 574–578.

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[11]Moorehead, M. B. Relative weights of the right and left sides of the body in the foetus. *J. Anat. & Physiol.*, 1902, XXXVI, 400–404.

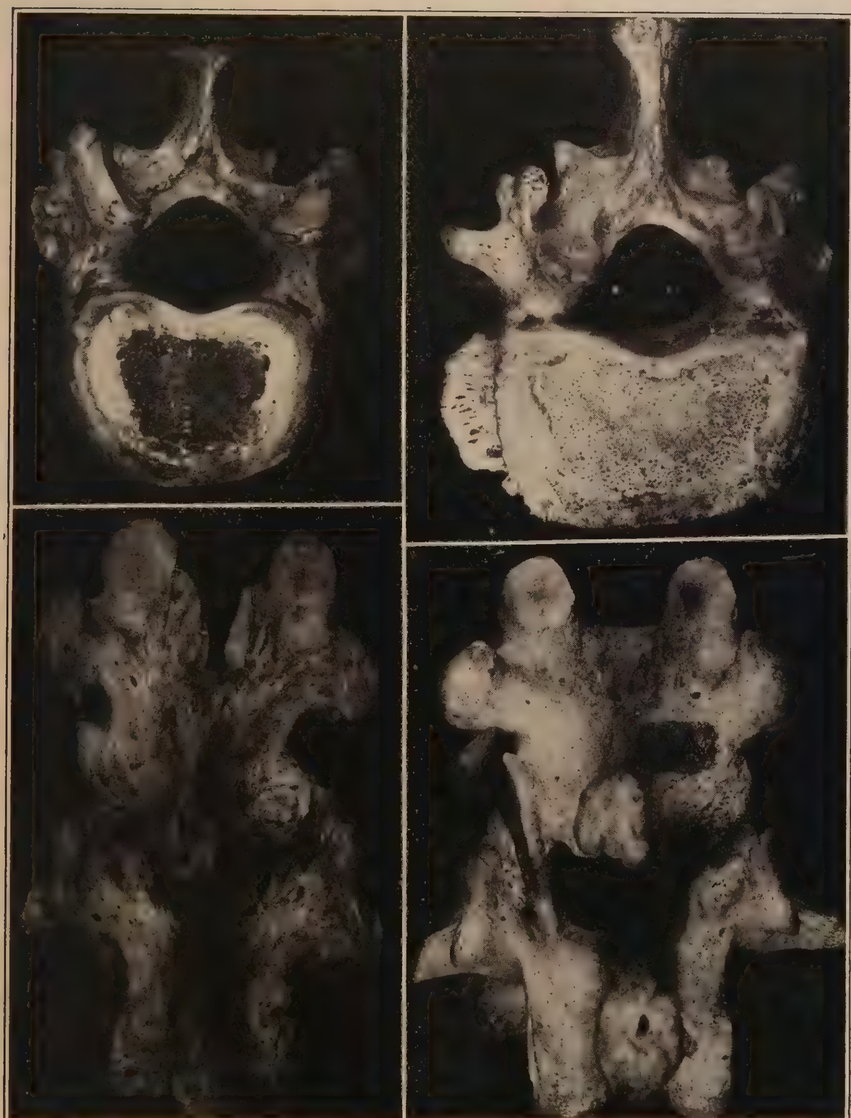

FIG. 1. (left) Eleventh and twelfth thoracic vertebrae of skeleton No. 272, showing the asymmetry of articular processes and facets as they appear in all but two of the anomalous series.

FIG. 2. (right) Eleventh and twelfth thoracic vertebrae of skeleton No. 244, in which the asymmetry of the processes is inverted in respect to the type shown in No. 272.

was left-handed according to the criteria mentioned and in this one the flat facet was on the right.

The amount of material presented is insufficient to draw a definite conclusion as to the relation of asymmetry of facets to handedness. However, the fact that the skeleton of the left-handed individual presented an asymmetry the mirror image of that seen in all but one of the right-handed skeletons seems to indicate that such a relation may obtain. However, the presence in the right-handed series of one skeleton (No. M.318) with an asymmetry identical with that of the left-handed skeleton must be explained before such a relationship may be said actually to exist. No. M.318 does not fit in with the series in at least three other respects, viz.: (1) the asymmetry occurs at a lower level (T_{12}–L_1) than is the case in the other spines; (2) this first lumbar vertebra possesses a costal facet on the right side articulating with a thirteenth rib; and (3) there are 25 movable vertebrae. The twentieth vertebra, has been reckoned the first lumbar because in all respects, save in the possession of a costal facet, it is characteristically lumbar; there are therefore six segments in the lumbar spine of skeleton No. M.318.

Summarizing the above observations it is apparent that asymmetry of articular processes is of relatively frequent occurrence in the series examined and is limited to the last two rib-bearing vertebrae. A larger series must be studied in order to determine the exact incidence as well as to compare the frequency in Whites and Negroes. In the majority of cases the asymmetry is of the type showing the flat facet on the right. If this condition were related to the right and left-handedness of the ordinary individual one would expect to find a much higher incidence. However, the fact that in the spine of the one left-handed skeleton in this series presenting asymmetrical facets the asymmetry is the mirror image of that evidenced in the great majority of right-handed skeletons suggests the possibility of there being a relation to an exaggerated handedness such as that brought about by certain occupations. There appears to be no relation between this variation and either the pathological scoliosis or the so-called "normal" scoliosis.

My thanks are due to Professor R. J. Terry and Dr. H. A. Harris for their advice and criticism in the preparation of this paper.

THE MOVABLE SEGMENTS OF THE VERTEBRAL COLUMN IN OLD EGYPTIANS

MILDRED TROTTER

INTRODUCTION

This work was done at Oxford University during the year 1925–26 when I was there as Fellow in Physical Anthropology of the National Research Council. I want to express to the National Research Council my deep appreciation of the opportunity thus afforded me.

A large series of Egyptian skeletons excavated in the Thebaid during the years 1898–1900 makes up part of the collection to be found in the University Museum. The date of these specimens ranges from early predynastic to Roman times, covering a period of over 150 generations, and as we have learned to expect from Egypt, the state of preservation of the skeletons is comparatively good. A detailed report of the crania of this series has been presented by Professor Arthur Thomson and D. Randall MacIver in *The Ancient Races of the Thebaid.* A smaller series of Romano-British skeletons excavated since 1912 is to be found in the Museum also. An account of the excavation may be found in *Excavations at Frilford* by L. H. Dudley Buxton.

The Egyptian series was selected for study because of the comparatively large number of specimens. The Egyptians are dolichocephals and the Britons are mesocephals. No differentiation could be observed in the vertebrae of the two races except that of size. Therefore, it was of distinct advantage to have the Romano-British columns for comparison in this study as we are dealing with races who lived under entirely different environmental conditions and were of different size and of diffierent cephalic index, the importance of which will appear in the next few paragraphs.

Statements in text-books differ considerably with regard to the average length of the vertebral column, nevertheless there seems to be general agreement in the theory that the lengths of the various segments of the column, i. e., cervical, thoracic, and lumbar, maintain a definite proportion to the whole or one to the other. The parachordal portion of the base of the skull, that part between the foramen magnum and the dorsum sellae, has in early development the same relation to the notochord as the vertebral column itself. With these points in mind, it would be of interest to ascertain whether the base of the skull might also bear a definite relation to the length of the vertebral column; and the

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present investigation was, at Professor Thomson's suggestion, undertaken to test the validity of these suggestions.

The importance of such an enquiry will be made clear if I quote from the Professor's paper on *Man's Cranial Form.* "Given two individuals with vertebral columns of equal length and the same volume of brain, the one, however, possessing a massive jaw, whilst the other displays but a feeble mandibular development, the chances are that the former will be dolichocepahlic while the latter will be a brachycephal. Again, given two persons of equal vertebral length with jaws of about equal development, we will find that the man possessing the greater volume of brain will have the rounder head. In both these instances I have laid stress on the vertebral length of the individuals being the same, for the men with the long columns have an absolutely longer cranial base than the men with the shorter columns, and when the same volume of brain is packed into the crania of these two types, we find that the degree of sphericity attained in the taller race with the longer base is less than that displayed by the crania of the shorter race with a corresponding shorter cranial base."

The first step in this investigation must necessarily be the testing of the hypothesis that the segments of the column maintain a definite proportion to the whole. This report is concerned chiefly with that question. It also incidentally presents results of much interest on sex variation, first, in the length of the vertebral column and secondly in the amount of curvature.

It is my great pleasure to thank Professor Thomson most kindly not only for putting all the facilities of his department at my disposal, but also for his constant interest and advice in the research. I am also deeply indebted to Mr. L. H. Dudley Buxton for giving me free access to the Romano-British bones, for teaching me such applications of Pearson's theory of correlation as have been used, and for his many other helpful suggestions.

MATERIAL

The collection examined is especially valuable because almost all the skeletons have been identified with regard to sex on archaeological as well as anatomical grounds. A careful examination of the whole collection led me to reject first all immature and unidentified skeletons, and secondly those adult Egyptian skeletons which do not belong to the Early Predynastic, Late Predynastic and the First and Second Dynasties, because the movable segments of the vertebral columns of these periods were more complete than those of the other periods.

There is a large number of sacra in the collection, but unfortunately only a very few have been identified as belonging to skeletons of these periods. Therefore, the report on the sacra will be made subsequently.

An occasional column of the selected group had at some time been treated; the untreated bones were in such fragile condition that it was absolutely necessary to harden them before handling for a detailed examination. They were dipped into a weak solution of glue, which made them sufficiently firm to undergo measuring. The Romano-British bones had been sized previously and were in excellent condition. With only a few exceptions the entire number of vertebrae of each column was preserved.

TABLE 1.

Egyptian Vertebral Columns

Sex	Complete	Complete less				Total
		Cervical	Thoracic	Cerv. and thor.	Cerv. and lumbar	
Male.........	15	2	1	–	1	19
Female........	24	2	2	3	–	31
Total.........	39	4	3	3	1	50

TABLE 2.

Romano-British Vertebral Columns

Sex	Complete	Complete less				Total
		Cervical	Thoracic	Cerv. and thor.	Cerv. and thor.	
Male.........	4	2	–	–	–	6
Female.......	5	1	–	–	–	6
Total.........	9	3	–	–	–	12

VARIATIONS

In the Egyptian columns an additional vertebra was found in one male thoracic segment (skeleton No. 459) and in one male (skeleton No. 1) and one female (skeleton No. 58) lumbar segment. In one female column (skeleton No. 66) the number of movable vertebrae was reduced to 23 this being effected by the reduction of the thoracic segment to 11 vertebrae. These results are in accordance with the researches of Fischel and others who found that the tendency to increase in the number of movable vertebrae is greater in the male, while reduction more usually occurs in the female, although reduction is distinctly rarer on the whole than increase.

The vertebrae are entirely normal except for the presence of marginal exostoses, which Hrdlička regards as the usual manifestations of age rather than of disease. The Egyptian bones are slightly smaller than the Romano-British which are heavier and more rugged in appearance.

MEASUREMENTS

The three following measurements were taken on the body of each vertebra:

(a) the ventral vertical diameter or height.
(b) the middle vertical diameter.
(c) the dorsal vertical diameter.

Martin's technique was followed in measuring all the vetebrae except the atlas and epistropheus. The atlas was discarded and in the case of the epistropheus the tip of the odontoid process served as the anterior, middle, and posterior point of the upper surface of the body of the vetebra.

LENGTH

In comparing the lengths of the columns I used the vertical diameter of the middle of the body. The results are tabulated in terms of millimeters.[1]

TABLE 3.
Average Total Length of Columns

Sex	Egyptian	Romano-British
Male	403.8 (15)	426.6 (4)
Female	372.9 (24)	400.6 (5)

The columns, of which a more detailed presentation of the measurements may be found in Table 4, are absolutely longer in the male than in the female in both the Egyptian and the Romano-British series, and the Romano-British series exceeds the Egyptian series in approximately the same proportion as the male exceeds the female, i. e. the Romano-British females are about the same in length as the Egyptian males.

TABLE 4.
Average Absolute Length of Individual Segments of the Columns

	Segment	Average length	Probable error	Standard deviation	Probable error	Coefficient of variation	Probable error
Egyptian Male	Cervical (15)	84.0	±1.24	7.1	± .87	8.4	±1.05
	Thoracic (15)	203.3	±2.49	14.3	±1.76	7.0	± .87
	Lumbar (15)	115.0	±1.36	7.8	± .96	6.7	± .84
Egyptian Female	Cervical (24)	75.6	± .54	3.9	± .38	5.2	± .51
	Thoracic (24)	188.0	±1.41	10.2	±1.00	5.4	+ .53
	Lumbar (24)	109.3	± .93	6.7	± .65	6.1	± .60
Romano-British Male	Cervical (4)	90.0	±2.15	6.4	±1.52	7.1	±1.70
	Thoracic (6)	216.0	±3.50	12.7	±1.97	5.8	±1.15
	Lumbar (6)	120.6	±1.67	6.0	±1.18	5.0	± .98
Romano-British Female	Cervical (5)	81.2	±1.66	5.5	±1.17	6.8	±1.45
	Thoracic (6)	203.6	±1.92	6.9	±1.36	3.4	± .66
	Lumbar (6)	115.6	±1.78	6.4	±1.26	5.7	±1.12

[1] The numbers in brackets in this table and in succeeding tables indicate the total number of specimens examined.

The length of the segments in the male columns exceeds the length of the corresponding segments in the female columns in both series. And, there is less range of variation in the female columns than in the male.

When the differences are studied statistically, taking into consideration the standard deviations, the coefficients of variation, and their probable errors there is no significant difference in length between the sexes within a series, although owing to the limited number of specimens in the two series, the size of the error may mask the existing difference.

Soularne has reported that the absolute length as well as the proportional length of the lumbar segment is greater in the female than in the male; his conclusions, however, are based on data from moist dissecting-room material. Although in both the Romano-British and the Egyptian series the absolute length of the lumbar segment was greater in the male, proportionally the two sexes very closely approximated each other but with a slight excess on the part of the female.

TABLE 5.

Proportional Lengths of the Segments

Segment	Length in per cent			
	Male		Female	
	Egyptian (15)	Romano-B. (4)	Egyptian (24)	Romano-B. (5)
Cervical	20.9	21.1	20.3	20.3
Thoracic	50.5	50.6	50.4	50.8
Lumbar	28.6	28.3	29.3	28.9
Total	100.0	100.0	100.0	100.0

CURVATURE

In studying the curves of the spinal column little attention has been given to the part played by the bones themselves with the exception perhaps of those contributing to the lumbar segment. Cunningham in his treatise on *The Lumbar Curve in Man and Apes* set the example of expressing the anterior and posterior measurements of the bodies of the vertebrae in the form of an index. His formula for determining the index of an individual vertebra is as follows:

$$\frac{\text{Posterior vertical diameter x 100}}{\text{Anterior vertical diameter}}$$

and the index of a segment called a general index and applied by Cunningham to the lumbar segment only is obtained by:

$$\frac{\text{Sum of the posterior measurements x 100}}{\text{Sum of anterior measurements}}$$

Therefore, either a vertebra or a segment with an index of 100 is neutral and contributes in no way to the formation of a curve. An index of 100+ signifies that the posterior measurement of the vertebra or the

sum of the posterior measurements of the vertebrae are greater than the anterior and tend to form a curve with a concavity directed forward, while an index of 100 – is indicative of a curve with a convexity directed forward.

TABLE 6.

General Indices of the Segments of the Column

Race	Segment	Male	Female
	Cervical	86.2 (16)	97.8 (26)
Egyptian	Thoracic	105.0 (18)	104.9 (26)
	Lumbar	100.0 (17)	99.1 (30)
	Cervical	94.1 (4)	92.9 (5)
Romano-British	Thoracic	107.4 (6)	103.7 (6)
	Lumbar	98.5 (6)	94.8 (6)

In the Egyptian series the female cervical vertebrae contribute a greater degree of convexity to the segment than do the male vertebrae. In the Romano-British series the reverse condition is true; the male cervical vertebrae contribute the greater degree of convexity to the segment. In both races, in the thoracic segment the male contributes a greater amount to the curve than the female, while the female presents the greater curve in both races in the lumbar segment. In other words, for the cervical segment there is disagreement between the two races as to which sex presents the greater anterior measurements—in the Egyptian it is the female, and in the Romano-British it is the male; for the thoracic and lumbar segments and for both races there is agreement between the sexes—the male predominating for the thoracic and the female for the lumbar.

TABLE 7.

Indices of Individual Lumbar Vertebrae

Vertebra	Egyptian		Romano-British	
	Male (17)	Female (30)	Male (6)	Female (6)
1	108.0	104.1	112.0	104.0
2	107.6	104.0	107.6	100.0
3	103.8	104.0	96.3	92.8
4	96.1	96.0	96.3	92.8
5	85.1	88.0	82.7	85.7

There is general agreement between the sexes within each race (Table 7), but a distinct difference between the two races in the amount of convexity directed forward as contributed by the bones. In the Egyptian series the index shows that the shape of the first three vertebrae in both sexes is unfavourable to a curve with the convexity forward while in the Romano-British group only the first two bones carry on the general curve of the thoracic region. It has been suggested that the degree of lumbar curvature is indicative not only of sex but also to what place a race should be assigned in the scale.

PROPORTION

The proportional length of the segments has been determined on the hypothesis that the sum of the middle heights of the vertebrae from the second cervical to the fifth lumbar inclusive is equal to 100.

TABLE 8.

PROPORTIONAL LENGTH OF THE SEGMENTS

	Male				Female		
Catalogue No.	Cervical	Thoracic	Lumbar	Catalogue No.	Cervical	Thoracic	Lumbar
Egyptian Series							
459	18.8	52.3	28.9	44	18.4	53.2	28.4
33	19.2	51.8	29.0	8	18.7	51.2	30.1
9	19.6	50.2	30.2	16	18.8	51.9	29.3
89	19.9	52.3	27.8	42	18.9	50.9	30.2
612	20.0	52.0	28.0	52	18.9	51.1	30.0
1	20.2	46.0	33.8	58	19.3	46.5	34.2
617	20.8	49.1	30.1	38	19.6	50.6	29.8
7	20.8	51.0	28.2	36	20.0	51.9	28.1
71	21.2	50.0	28.8	66	20.1	48.1	31.8
57	21.2	52.4	26.4	22	20.1	51.4	28.5
610	21.5	50.4	28.1	92	20.4	50.1	29.5
69	21.8	50.1	28.1	112	20.4	50.1	29.5
19	22.0	49.8	28.2	100	20.4	51.3	28.3
37	22.1	50.3	27.6	30	20.5	50.2	29.3
73	22.7	48.7	28.6	88	20.5	51.0	28.5
				18	20.5	51.5	28.0
				80	20.5	52.0	27.5
				40	20.6	49.4	30.0
				76	20.8	51.5	27.7
				24	20.9	51.7	27.4
				2	21.9	47.7	30.4
				10	21.9	48.7	29.4
				428	22.2	49.5	28.3
				456	22.7	49.8	27.5
Romano-British Series							
32	20.2	50.5	29.3	17	19.2	52.2	28.6
38	20.5	51.5	28.0	12	20.0	51.0	29.0
8	21.6	49.0	29.4	30	20.3	50.7	29.0
9	21.6	52.0	26.4	27	20.7	50.0	29.3
				1	21.0	51.0	28.0

There is a wide range of variation between the columns and very little, if any, correlation appears to exist between the segments. The mathematical determinations bear out these conclusions drawn from inspection.

In the Egyptian series there is no correlation; each coefficient is less than .3. Although the number of specimens in the Romano-British series is much smaller and the probable errors in each case much larger, neverthless there appears to be a fairly well-marked relationship in at least three instances. The most conspicuous is the coefficient of correlation between the male cervical and thoracic segments; those for the cervical and thoracic and the lumbar and cervical in the female are also

TABLE 9.

Coefficients of Correlation Between the Segments

Segments	Male Coefficient of correlation	Probable error	Segments	Female Coefficient of correlation	Probable error
Egyptian Series					
Cervical and Thoracic (15)	.27	±.16	Cervical and Thoracic (24)	.25	±.16
Lumbar and Thoracic (15)	.17	±.16	Lumbar and Thoracic (24)	.09	±.13
Lumbar and Cervical (15)	.26	±.16	Lumbar and Cervical (24)	.19	±.13
Romano-British Series					
Cervical and Thoracic (4)	.53	±.24	Cervical and Thoracic (5)	.42	±.31
Lumbar and Thoracic (6)	.13	±.27	Lumbar and Thoracic (6)	.17	±.26
Lumbar and Cervical (4)	.26	±.31	Lumbar and Cervical (5)	.45	±.23

high, viz. .45. For such a small series the results are suspicious and the dependability of the figure may be tested by calculating from one set of measurements what the other should be and comparing them with the observed measurements. For example, the highest coefficient of correlation is .53 in the male cervical and thoracic group. This is based on four examples. Let us accept the thoracic lengths and determine what the cervical measurements should be when the coefficient of correlation is .53.

Skeleton No.	Observed cervical lengths	Calculated cervical lengths	Differences
32	79	85	+6
9	93	91	−2
8	93	89	−4
38	95	96	+1

However, it is by a hit-and-miss process that the results so closely approximate each other. In the following example of the female lumbar and cervical segments, the group with the next highest coefficient of correlation, viz. .45, there is a difference of only +.5 between the observed and calculated lumbar measurements.

Skeleton No.	Observed lumbar length	Calculated lumbar length	Difference
17	109	111	+2
1	111	117	+6
12	114	114.5	+0.5
30	116	116	0
27	128	120	−8

In this group one calculated length checks exactly with the observed while a second exceeds it only by +0.5. A third calculation differs by +2 while the remaining two are very far afield from the observed lengths.

Certainly the Romano-British series is too small for statistical study

and the two examples show how misleading the results may be. It is true that the Egyptian series is not a large one yet the number of specimens is sufficiently great to expect an indication of correlation if such exists. It would be extremely interesting to test the hypothesis on a very long series and quite necessary before it may be said that there is no intra-racial correlation. Although the evidence is insufficient it tends to suggest the existence of an inter-racial correlation.

CONCLUSIONS

It must be borne in mind that the following conclusions are based on the examination of the movable vertebrae alone and that the intervertebral discs, which were not available, do play a very large part in determining the length as well as the curves of the vertebral columns.

1. The male columns are absolutely longer than the female in both the Romano-British and the Egyptian series.

2. The length of the Romano-British columns exceeds the length of the Egyptian columns in approximately the same proportion as the length of the male columns exceeds the length of the female columns.

3. The length of the segments in the male columns exceeds the length of the corresponding segments in the female columns in both series.

4. There is less range of variation in the length of the female columns than in the length of the male columns.

5. Conclusions may not be drawn concerning the difference in length between the sexes within a series, because of the large probable error which may mask the true relationship.

6. In the female group in both series the lumbar segment was proportionally longer than in the male group.

7. The Egyptian female cervical vertebrae contribute a greater degree of convexity directed forward to the segment than do the Egyptian male cervical vertebrae; the Romano-British male vertebrae when compared with the female contribute the greater degree of convexity directed forward in the segment.

8. In both races the male vertebrae contribute the greater degree of concavity directed forward in the thoracic segment.

9. In both races the female vertebrae contribute the greater degree of convexity directed forward in the lumbar segment.

10. In the Egyptian series the first three lumbar vertebrae are unfavourable to a convexity directed forward while in the Romano-British series only the first two lumbar vertebrae are unfavourable to a convexity directed forward.

11. In the Egyptian series there is no correlation in length between the segments; in the Romano-British series the coefficients of correlation may not be depended upon because of the small number of specimens.

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GROWTH OF INTERPUPILLARY DISTANCE IN AMERICAN NEGROES

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There are few data of changes with growth of interpupillary distance on record, and none of the differences which are found between groups of different racial stock. The material which is presented here is the result of measurements taken on American Negro boys at Public School 89, Manhattan, New York City, and on male adult Negroes both in New York City and at Howard University in Washington, D. C.[1] The study for which this material was gathered is one of variability under racial crossing, in which the mixed population of Negroes found in this country is being considered. A great number of traits have been measured, which, in the main, are those which represent differences between Negroes and Whites. Since, in general, the face of the African is larger in most dimensions than that of the European, interpupillary distance, as well as the distance between the inner and outer corners of the eyes, was included.

The importance of knowing how interpupillary distance changes with growth, and also the differences in racial groups, is obvious where study of the development and utilisation of the visual processes is involved. Therefore, the following data are given. Interpupillary distance was measured, in this study, by means of the sliding calipers. The branches were held directly under the eyes at points corresponding to the centres of the pupils, and the subject was asked to look at a spot on the wall opposite him, at a sufficient distance so that the pupils of the eyes would be directed straight forward, and not turned inward as they would be if the spot observed were close to the subject. This was not always an easy matter in the case of small children, but I usually succeeded in getting the measurement without too much difficulty. I was directly in front of the subject, and he looked over my head at the point mentioned.

In order to know the degree of error which might be expected in any one measurement of this trait (and hence in a series of them) made by

[1]The courtesy of the Principal of P. S. 89, Dr. Jacob M. Ross, and of his staff, and of the President and Faculty of Howard University, in extending to me the facilities of their respective institutions during the course of this study, is deeply appreciated. This research is being carried on under a Fellowship of the Board of the Biological Sciences, National Research Council, and the work at Washington was made possible by a special grant from the Committee on Human Migrations, of the National Research Council.

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myself, since all these measurements were made by me, I measured 78 boys at Public School 89. These remeasurements were made on different days, and, of course, the second set were recorded on fresh blanks. The average observational error for interpupillary distance is .68 mm., which is so small that it may be disregarded when the means below are presented.

The age classes are centered about the half-year,—that is, 5–6 years means from 5 years 1 month to 5 years 11 months. On the case of the children, age in days, months, and years was calculated, while in the case of the adult sample, that for the year only, to the nearest six-months. The adult sample is given without division into age groups, and ranges from 17 years of age up to 40, in the main, altho there are a few cases which are above that age. The largest proportion of the sample, however, is by far that of the decade 18–28. The means and standard deviations are:

Age	Number of cases	Mean (mm.)	Standard deviation
5–6	21	54.2	±2.6
6–7	52	57.85	±3.4
7–8	98	57.0	±2.5
8–9	121	58.6	±2.9
9–10	126	59.6	±2.65
10–11	133	59.6	±2.6
11–12	136	61.9	±2.9
12–13	124	61.7	±3.25
13–14	140	62.5	±3.2
14–15	116	63.2	±3.2
15–16	80	64.2	±3.2
16–17	31	64.9	±3.3
Adult	529	66.4	±3.8

It will be seen that there is an increase in the means as the children grow older, with one or two exceptions, probably due to chance, culminating in an adult mean of 66.42 mm. for the Negro adults. The variabilities increase with growth, as would be expected, since this is a common phenomenon.

The degree of mixture represented by the individuals in these samples is of interest, and the differences which racial mixtures of different amounts bring about. Altho it cannot be known, in the case of the children, just what amounts of crossing are represented by the boys, since they could not be expected to give reliable genealogical information, and no other satisfactory tests of racial mixture have been devised, at the same time it may be fairly assumed that there is no great difference between their racial composition as a group and that of the adult sample for which mean interpupillary distance was given. These men were each asked to give a genealogy, and I have been able to show, thru comparisons for the averages of such traits as skin color, nostril

width, lip thickness, and other distinctive Negroid characters for groups of different amounts of Negro, White and Indian crossing (on the basis of their own statements) that these genealogies are, for groups, at least, quite valid. The differences between such traits as I have mentioned are particularly significant, since there are great differences in them between African Negroes and Whites. The group which claims to be unmixed Negro show means in these and other traits which closely approximate the means for African groups living where the ancestors of the American Negroes most probably lived, while with increasing amounts of White blood as given in the genealogies, the means approach those for White populations.

The percentages for various degrees of mixture represented by the Howard University and New York City adult male Negroes, by their own statements, are:

Unmixed Negro	20.3%
Negro and Indian	6.7%
More Negro than White	23.8%
More Negro than White, with Indian	9.6%
About the same amounts of Negro and White ancestry	17.7%
About the same amounts of Negro and White ancestry, with Indian	10.6%
More White than Negro	5.6%
More White than Negro, with Indian	5.7%

As has been said, it may be safely assumed, since the standard deviations for the New York children are so close to those for the adults, that this would represent approximately the amount of mixture in the New York children's genealogies if these were obtainable. This is seen even more clearly, if we compare the means for the genealogical classes with the few data for pure White series available and with Todd's series of Negro cadavera. Therefore, the difference in interpupillary distance between these genealogical classes may be assumed to be, in children, as variable, taking the growth element into consideration, as it is in the adults, where it varied for the several genealogical classes as follows:

	No.	Mean	Standard deviation
W. R. U. Negro cadavera[1]	100	68.4	±4.4
Unmixed Negro	108	68.1	±3.0
Unmixed Negro with Indian	36	66.98	±4.0
More Negro than White	125	66.4	±3.7
More Negro than White, with Indian	51	67.1	±3.7
About the same, Negro and White	93	66.3	±3.4
Do., with Indian	56	65.3	±3.9
More White than Negro	29	64.6	±3.1
More White than Negro, with Indian	31	63.4	±3.7
20-year-old Munich boys[2]	?	52.5	?
White soldiers, presumably German[2]	5000	62.2	?
W. R. U. White cadavera[1]	100	63.4	±4.2

[1]Todd's W. R. U. figures for this trait are as yet unpublished.
[2]Martin, Lehrbuch der Anthropologie, p. 163.

If we consider only the classes without Indian mixture, it can be said that there is a decrease in interpupillary distance with greater amounts of Negro blood, an observation born out by the few comparative data available. This is also true, but with less regularity, in the cases of the groups mixed with Indian. But these means follow the result to be expected if, as was said in the beginning of this paper, the Negroid face is broader than that of the White.

PALMAR AND PLANTAR EPIDERMAL RIDGE CONFIGURATIONS (DERMATOGLYPHICS[1]) IN EUROPEAN-AMERICANS

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FOREWORD

The study here related was carried out in conjunction with an investigation of racial dermatoglyphic distinctions in Jews. Comparisons with European-Americans were particularly desired, and it was necessary to be provided with a comparative material adequate to the purpose. Neither Keith's ('24) nor Montgomery's ('25) data completely satisfy the requirement. While Wilder's records are otherwise

[1]The term "dermatoglyphics" (derma, skin, + glyphē, carve) is used herein for the first time, barring its verbal introduction at the forty-second annual session of the American Association of Anatomists, April, 1926. It is proposed both as a designation of the division of anatomy embracing the surface markings of skin, within the limits defined below, and as a collective name for the integumentary features themselves. Manifestly, the literal sense of the word is more especially applicable to the skin of the palmar and plantar surfaces, with its configurations of sharply sculptured ridges. The intention of the proposal is that the term be limited in its regional application to skin surfaces thus marked, including not only the hand and foot but also such regions as the tails of certain forms which bear similarly specialized skin. As a name for the skin markings, dermatoglyphics applies only to ridges and their arrangements, flexion creases and other secondary folds being without the bounds of its intended meaning.
No explanation seems necessary for the coining of a term for which the demand is so apparent. Professor Wilder has been interested in filling the long-recognized hiatus in terminology; we wish to acknowledge indebtedness to him both for actuating our own search and for friendly criticism of its product.

suitable, being in fact the model of our own, his material is limited to females. In view of possible sexual differences, and especially since considerable variation was observed in statistics derived from the collection of Jews as compared with the corresponding figures published by Wilder, it seemed essential that the European-American data be extended to a larger body of material, and including both sexes. The present study was accordingly planned, not only to meet the need of its stated immediate application, but also in anticipation of an inquiry into the matter of sexual variation in dermatoglyphics. In view of the latter intention, tabulations are so arranged as to permit future reference to the male and female collections separately, although at present no point is made of sexual distinction.

In supplying the dermatoglyphic records of 200 European-Americans this study is simply an extension of the data hitherto recorded. With increased numbers of individuals statistical values for the various features attain a correspondingly greater reliability. Moreover, the 200 individuals are males, and thus form a natural complement to the parallel records of Wilder for females. As an auxiliary contribution we present also the results of an inquiry into the adequacy of the accustomed procedure in the statistical treatment of palmar main lines, with tests of a proposed revised grouping of main lines in statistical comparisons.

MATERIAL AND METHODS

The material here recorded for the first time consists of 200 males, almost without exception students of Tulane University. Its content may be described as European-Americans in which derivation from the British Islands preponderates. Excepting British-Americans, individuals who have declared their families to be unmixed French, Italian, or otherwise homogeneous are not included. There are no Jews in the collection. In view of the known inheritance of configurations it should be emphasized that no individuals of determinable family relationship are included in the series. It is conceivable that statistics indicating the occurrences of particular features might be distorted by the introduction of several members of a family in a relatively small collection.

Toward the end of convenient comparison Wilder's figures on females are introduced here in relation to the corresponding ones for males. His material, drawn from the student population of Smith College, is analyzed in several publications, of which a recent paper ('22) gives a collective account. Statement to the contrary being lacking, it is

assumed that Wilder's collection may include some closely related individuals. Obviously, the conditions obtaining in his sample of the college student group would admit of only rare instances, negligible in a collection of 200. Considering the nature of the racial material designated European-American, it is of course highly improbable that the collections studied by Wilder and ourselves are of homogeneous composition. Wilder gives no explicit statement covering the composition of his material, but in a publication devoted to bodily proportions (Wilder and Pfeiffer, '24) the nationalities in an assemblage of 100 Smith College students are listed (pp. 453–454). A comparison of this list with our own records shows that the distribution of nationalities is fairly close. Thus, considering that the assemblage used for bodily measurements is representative of the student population likewise serving for Wilder's dermatoglyphic studies, there seems to be little cause to question the propriety of combining the material from the two sources, as we have done.

While the results of Wilder form the object of comparison with the data now at hand, notation should be made of Keith's and Montgomery's figures, which with Wilder's and the present results represent the entire body of European-American material which has been placed on record. Keith's racial comparisons do not extend to distinctions among the Caucasian peoples, and her collection of 100 "Whites" is not further characterized. However, Dr. Keith has been so kind as to supply information by letter. It is still impossible to state definitely the makeup of this collection, but we are inclined to believe that it contains a goodly quota of stocks which were avoided in our series of males. Dr. Keith lists the names of 70 of the individuals, many of which at least suggest the truth of this belief. Sexes are not distinguished, but the given names indicate that females outnumber males in a proportion of about 2:1. With respect to the remainder of her collection Dr. Keith remarks that "a larger percentage were undoubtedly Jewish." Dr. Montgomery also has been very kind in supplying information concerning the material on which he has published in connection with the use of sole prints in identification. His collection includes 191 infants born in the Madison General Hospital, Madison, Wisconsin. He writes: "The stock represented is, to the best of my knowledge, amalgamated European-American. In this series there are about five or six Jews and as many Sicilians mostly of foreign-born parents. No race preponderates." Sexes are separated in the published lists. We take this occasion to express appreciation both to Dr. Keith and Dr. Montgomery for their supplementary data.

The features to which attention is directed herein comprise palmar main lines, palmar patterns, and plantar patterns. While apical patterns of the digits in our material have been analyzed, as a matter of expediency their presentation is reserved for later publication as comparisons with them are demanded. For concise indication the collective material is assembled in the following table.

TABLE 1.

SHOWING THE CONTENT AND OBJECT OF STUDY IN THE TWO COLLECTIONS. THE NUMBERS INDICATE INDIVIDUALS, EACH OF WHOM IS REPRESENTED BY BILATERAL PRINTS.

	Males Cummins and Midlo	Females Wilder
Palmar main lines	200	200
Palmar patterns	200	100
Plantar patterns	200	200

Prints of the palm and sole were made by the usual printers' ink process. Each set of prints of a single individual was assigned (at the time of printing) an accession number. In tables 7, 17, and 19 it will be noted that the accession numbers range from 1 to 760. Lest there be a misconception aroused by this circumstance it is to be stated emphatically that no selection of the actual prints was made. On the contrary, the entire print collection in the possession of the writers was canvassed for qualified sets, and without examining the prints themselves; the interruptions in the numbered series were occasioned by a selection of *individuals* in accordance with the requirement of the study.

In passing, a procedure which has been found useful in obtaining complete palm prints may be recounted. There are three regions which are often difficult to record completely in a single print of the palm. The areas in which difficulty is encountered are: (1) the distal margin, which bears most essential features; (2) the carpal triradius, when at or near the proximal margin; and (3) the "hollow" or central area of the palm. The importance of the dermatoglyphic features included in these areas necessitates that they be recorded in some manner or other, and the usual resort is the making of supplementary prints to accompany that of the entire palm. Stockis ('21) asserts that the resulting print is good when the palm is first completely inked, and then printed by passing over it a wooden roller on which the paper is bound. We have not tested this method for the reason that a much simpler process yields palm prints of the desired completeness. It may be noted that Stockis applies his method also to the sole, although here the need for a print in which the entire territory is represented in a continuous expanse is not so imperative as in the palm.

Our routine printing includes two impressions of each palm. The palm is first registered as completely as possible by the customary method, that is, by placing the inked hand upon a paper which rests on a smooth rigid surface (glass usually), whereupon pressure is applied by the operator especially over the refractory regions. Many of the prints so obtained are complete in all respects. A second print of each palm is made by the following method, which if carefully carried out may be relied upon to give a complete and clearly defined impression. Areas remaining uninked after contact with the ink plate are carefully gone over with the roller. Then with the palm facing upward a sheet of paper is laid upon it, and the operator puts his hand to the paper in a position diagonal to the axis of the hand beneath. With the exertion of gentle pressure the desired approximation of the inked palm and paper is readily secured. Shifting must be avoided, or the print will be blurred.

Methods of formulation are discussed separately in sections below, in company with the dermatoglyphic features which they symbolize.

There is reason to believe that certain details, noted in their appropriate relation in the text, are susceptible to varying interpretations by different observers. In studying the collection of males our collaboration has been arranged both to avoid frank errors and to check judgments on points wherein interpretations may vary. Initial interpretations were made by one of us independently, subjected to critical examination by the other, and questioned points were then considered jointly.

Palmar Main Lines

DEFINITION

The abutment of areas characterized by contrary ridge directions, as of patterns against patterns, patterns against open fields, or open fields against other open fields of opposed ridge alignment, is associated with the presence of the elements known as *triradii* or *deltas*. Each triradius is a triangular consolidation of ridges, widely variable in its details of construction (minutiae) but always marking the meeting point of ridges which course in three chief directions. Ridges leading from the three points of a triradius are its *radiants*.

Among the variously situated palmar triradii there occurs typically a series of four at the distal border. By virtue of their position these are known as *digital triradii*, one being located at the base of each of the four fingers. Digital triradii represent the origins of the *palmar main lines*. From each triradius two radiants are extended distotransversely

toward opposite margins of the neighboring digit, forming the proximal embracement of a narrow interval of ridges thus isolated as the *digital area*. The third or proximal radiant of each triradius is directed upon the palm as a *main line*. The main lines are individually designated A, B, C, and D in radioulnar sequence, taking their names from the triradii of origin, namely, a, b, c, and d (or first, second, third, and fourth).

METHOD OF FORMULATION

Corresponding main lines vary considerably in different palms, as do the four lines in a single palm. The variations to which the individual main lines are subject comprise differences in course, and sometimes a line may be rudimentary or even wholly lacking. The analysis of such variations, extending also to the four lines in combination, forms an important part of any investigation dealing with palmar dermatoglyphics. In recording the variations it is necessary to resort to the construction of descriptive formulae. The universally adopted procedure in formulation is that devised by Wilder (see especially Wilder, '16, and Wilder and Wentworth, '18). The courses of main lines are indicated in the formula by numbers, each number signifying a more or less definite marginal area of the palm or another main line. Additional characters denote absence or abortive development of a line. Thus, the formulation of the main lines of a palm consists of a series of four characters. Wilder's system is followed herein except for two slight modifications which are related below.

When a line (it is line C to which especial reference is made, since the variations in question are almost wholly confined to this one) neither reaches a palmar margin nor fuses with another main line, there are, according to Wilder and Wentworth, the following three possibilities of variation, with the suggested symbols for formulation.

"1. Runs straight down into a loop, and stops, 8
2. Forms a little loop or circle upon its digital line, 8
3. Wholly absent, together with its delta, 0"

Loth ('10) previously had recommended the use of the letter X as a symbol for any of the variants listed above, and Wilder ('22) since has substituted X for O as an indication of complete absence of the line. Hasebe ('18) instituted the use of X in formulating a short rudimentary line, with total absence signified by an X enclosed within parentheses; his usage is followed by Miyake ('26).

Although somewhat hesitant in contributing further to a state of confusion, the writers suggest that O is a preferable symbol for the ex-

pression of complete lack of a line, and do not fear, with Wilder and Wentworth, that "the digit O, standing alone, is a little awkward in a formula, and is liable to be confused with a 6 or an 8." Furthermore, it is suggested that X is to be preferred to the numeral of the main line in designating the rudimentary form of the line. The election of a numeral in this connection implies that the line is recurrent to itself, a relationship attained only infrequently. The symbol X is noncommittal, and as an added advantage, it is a more conspicuous and distinctive character in the written or printed formula. As applied in the formulae listed in this paper, X signifies a rudimentary line of any form, and O, the absence of a line. As suggested above, the demand for such symbols is practically restricted to line C, but at need they may be applied to any line.

With regard to the carpal triradius, an element added to the formula, reference should be made to Wilder ('22, p. 170), whose characterizations we have followed. Under the symbol C^h we have indicated all of the high carpal triradii, whether or not associated with hypothenar patterns.

A feature of the main line formula meriting particular attention is the termination of main lines on the ulnar border of the palm. Wilder divides the ulnar border into three zones. To the hypothenar pattern, when present, is assigned the numeral 4, so that the formulation of a line in this position denotes that the line is incorporated into the pattern. That extent of the ulnar margin distal to the site of the hypothenar pattern is indicated by 5, and the extent proximal to the pattern is called 3. When the hypothenar pattern is lacking 5 is employed to represent the distal two-thirds of the margin, and 3 for the proximal one-third. While the inexactness of these values is partially compensated by the order in which the formula is stated (D, C, B, A), it seems desirable that the value of 5 be restricted, to the advantage of a greater precision in the indication of obliquity of the main lines terminating in this region. The writers have attempted to make such a modification of the formula by adding qualifying exponents to 5, so that while the formula presents no difficulty in the way of comparison with already published data, at the same time it furnishes a more proximate basis for any future study in which this detail may be considered. In all cases where a line does not actually become involved in the hypothenar pattern, its termination within the proximal one-third of the ulnar border is indicated by 3, and a termination within the distal two-thirds of the margin is stated as 5, as in Wilder's formulation. But the distal two-thirds is itself divided into thirds—distal, middle, and proximal—indicated in

the formula as 5″, 5′, and 5, respectively. In this connection may be mentioned a departure from the usual designations of the ulnar border employed by Keith, who uses 4 in application to terminations "at the side of the hypothenar region," not limiting position 4 to those cases in which a line is embodied within the hypothenar pattern.

METHODS OF STATISTICAL COMPARISON

Having assembled a collection of interpreted palmar main lines, reduced to formulae, the next step customary in any study entailing comparisons with other collections is the analysis of the incidence of certain characteristics, as follows:

(1) Terminations at the individual numbered intervals of the palmar margins, or fusions with other main lines, separately for each of the four lines. (2) Abortive development or absence of line C. (3) The combinations of main lines in individual palms, as represented by the complete formulae. All three calculations aim simply for indications of frequencies. For the first two, where individual main lines are considered separately, there is no choice as to the method of handling the data. But from the nature of the main line combinations, and considering the significance of their representations in formulae, some degree of uncertainty may exist as to the manner in which the formulae should be analyzed for adequate comparisons. It is with this question that the next succeeding paragraphs are concerned.

There is general agreement, as revealed by the treatment accorded to main line combinations in recent studies, that it is not sufficient to consider the incidences of individual formulae. Such comparisons probably would be of questionable significance, since dissimilarities in numerical composition of the formulae may be occasioned by very slight differences in the objects themselves, with consequent wide scattering of formulae. To cite examples illustrating the distribution of formulae: in a collection of 400 palms of European-American females (Wilder, '22, Table 14) there are 63 main line formulae, and in Miyake's ('26) series of 268 Korean palms 36 formulae occur. The problem, therefore, exists in determining a method of grouping the formulae in accordance with some provision determined by their natural affinities.

The accepted mode of thus grouping the formulae is suggested by the widespread occurrence of certain main line combinations, namely, 7.5.5.5; 9.7.5.5; and 11.9.7.5. Line A, which is described by the fourth element in the formula, may terminate as well in positions 1, 2, 3, or 4 without signifying any change in the fundamental arrangement of the

distal configurations. Accordingly, there are added to each of these three formulae all others in which line A terminates in the specified lower positions. Line C, often rudimentary or even wholly lacking, adds another line of variation from the characteristic formulae. When this line is ill-developed or absent and the formula permits otherwise, it is considered a related variant, at least for the two latter characteristic formulae. With these provisions, it may be said that a large share of the main line formulae of any race, so far as known, is apportioned among the following: 7.5.5.–; 9.7.5.– (or 9.X.5.–); and 11.9.7.– (or 11.X.7.–).

Our attention was drawn to possible deficiencies in this grouping of main line formulae by the disparity in incidences established for the Japanese by Hasebe ('18) and Wilder ('22). Hasebe investigated a series of 276 individuals (552 palms) and Wilder had at his disposal 195 individuals (390 palms). Their findings are compared in Table 2 below, Wilder's figures being transcribed directly from his Table 15a, and those of Hasebe computed from his list of formulae on pp. 16 and 17.

TABLE 2.

Percentile Incidences of the Characteristic Formulae in Hasebe's and Wilder's Collections of the Japanese.

	Hasebe	Wilder
7.5.5.–	33.3	24.3
9.X.5.– / 9.7.5.–	30.2	19.0
11.X.7.– / 11.9.7.–	22.6	16.6

It may be true that the inconsistent figures shown in Table 2 are to be accounted for on the basis of the size of the collections, as Wilder intimates, or by unlike selection of the material. Nevertheless, it is disconcerting to find so marked a variation in two samples of the Japanese, when comparisons of different racial groups are to follow the same method. There is positively no question of the existence of racial unlikenesses in main lines (see especially the publications of Wilder), yet some uncertainty is admitted generally with respect to the weight of small statistical differences.

The present writers are inclined to believe that main line formulae have been treated too empirically in their grouping for statistical comparisons, and that a source of error exists in the practise. We are prepared to present not only a criticism of the current disposition in comparisons but also some suggestions directed toward minimizing this source of error. As demonstrations of the usefulness of the suggested treatment of main lines the figures of Hasebe and of Wilder are redis-

posed, for comparison with their results arrayed in Table 2. Moreover, the data on European-Americans are arranged both in accordance with the now current method and with the proposed revision.

In examining the question of how to group main line formulae the significant expression of the individual formula is naturally a matter of primary consideration. The formula is, of course, only a means of reducing to a simple record the varied courses of main lines. While its first significance is merely descriptive, the value derived from it in establishing comparative relationships (as of race, sex, dextrality) exists largely in the fact that the formula pictures the radial extent of transversality of ridge courses over the distal area of the palm. As will be apparent in our discussion below, the present writers believe that in comparative studies this function of the formula is virtually its sole significance. Some elements of the formula are descriptive of features which bear no relationship to the expression of general ridge direction, in portraying simple local conditions of patterns. Unless some provision be made properly to discount these adventitious features it appears that the object of primary comparison, namely transversality, may be obscured. The groupings hitherto effected, while aiming at the stated comparison, fail to discriminate between the adventitious elements of the formulae and those which are truly valid criteria of the object of comparison. It should be noted that there is no need to depend upon the main line formula for indications of patterns and other local features, since these are separately considered.

A further issue against the present grouping is taken on the ground of artificial distinctions imposed by a too strict adherence to symbols in the formula, *per se*. From the standpoint of general ridge direction, which is sought in the comparison of main lines, there is, for example, no real distinction between 7.5.–.– and 8.6.–.–, between either of these and 7.7.–.–, or between 11.9.–.– and 11.10.–.–, where the differences may amount to an interval of only a ridge or two in tracing. It is interesting to note that Wilder has long recognized the truth of this assertion, without, however, having taken the matter into account in his comparative racial studies. In 1904 he writes: "It will appear at once that any near approach to one another of lines C and D would admit of three varieties: (1) where C is below D, (2) where they meet, and (3) where C passes above D; or 7.5., 8.6., and 9.7., respectively, and these three forms would be practically the same."

Moreover, the present groupings may ignore a large share of the main line formulae, in that only those related to the three typical series are

considered. To refer to illustrative data, Wilder's ('22) Table 15a may be cited. Here, for the Chinese, Japanese, and European-Americans the totals of all three of the typical formulae in each collection amount respectively to but 50%, 59.9%, and 52.4%; approximately half of the number of palms in each collection are ignored in the comparisons. Is it not pertinent that we should inquire into the main lines of this remainder? Transversality is a character naturally subject to variation in a continuous progression. The typical main line formulae are only segments of this progression, and as pointed out above they are limited by partly artificial distinctions.

In passing to the constructive suggestions it is first necessary that some insight be obtained into the range of variation of main line combinations (whole formulae). Toward the end of assembling a comprehensive material for this purpose the writers have inspected lists of formulae in the publications of Hasebe, Keith, Loth, Miyake, Schlaginhaufen, and Wilder, which with a conveniently accessible list of 800 formulae in our own files gives a total of upwards of 4000 palms. There is a fairly extensive racial representation in the collection as a whole, which contains European-Americans, Poles, Jews, Chinese, Japanese, Ainos, Koreans, Ceylonese, West Indians, Filipinos, Hawaiians, South American Indians, and Negroes (both native Liberians, and the blacks in America). The various peoples are not equally represented, nor is the collection large enough to contain all the possible combinations of main lines. Nevertheless, it furnishes the desired working basis, and it seems hardly necessary to supplement the list of known formulae by constructing others which are anatomically possible and which may be expected to occur at least sporadically in further collections.

From the entire series we have compiled 171 different formulae. This number would be considerably increased if the instances in which a line (C especially) is wholly lacking were distinguished from cases in which it is only incomplete; in the compilation either condition was recorded as "X," the discrimination between them being irrelevant to our purpose. Inasmuch as all common formulae (the first three symbols) show line A terminating in the five positions of the ulnar and proximal borders (1, 2, 3, 4, 5) a condensation of the list is warranted. On the assumption that it is only the low incidences of many formulae (in which like topographic relations could be realized) all formulae allowing the deletion of line A have been so condensed. This shortened series of formulae is presented in Table 3.

TABLE 3.

LISTING THE PALMAR MAIN LINE FORMULAE FROM A SERIES OF OVER 4000 PALMS (SEE TEXT), LINE A BEING OMITTED IN ALL BUT THE EXCEPTIONAL CASES WHERE IT DOES NOT TERMINATE ON THE ULNAR OR PROXIMAL BORDER. SIX FORMULAE FOUND IN THE LITERATURE ARE OF DOUBTFUL INTERPRETATION; THESE ARE IDENTIFIED BY ASTERISKS.

1.1.1.1	7.7.6.–	*9.X.7.–	11.7.6.–
1.7.1.1	7.7.7.7	9.9.5.–	11.7.7.–
5.5.5.–	7.X.5.–	9.9.6.–	11.X.7.–
X.4.4.–	7.X.7.–	*9.9.7.–	11.X.7.11
X.5.4.–	7.9.5.–	*9.10.8.–	11.X.9.–
X.5.5.–	7.9.5.11	10.7.5.–	11.X.X.–
X.7.5.–	7.9.6.–	10.7.6.–	11.9.6.–
X.X.5.–	7.9.7.–	10.7.7.–	11.9.7.–
X.9.5.–	7.10.8.–	10.7.8.–	*11.10.5.–
7.4.4.–	7.11.9.–	10.X.5.–	11.10.6.–
7.5.3.–	8.6.5.–	10.X.6.–	11.10.7.–
7.5.4.–	8.7.5.–	10.X.7.–	11.10.8.–
7.5.5.–	9.7.4.–	10.9.5.–	11.11.8.–
7.5.5.11	9.7.X.–	10.9.6.–	11.11.9.–
7.5.9.–	9.7.5.–	10.9.7.–	12.X.7.6
7.6.5.–	9.7.6.–	10.10.6.–	12.9.7.6
7.7.5.–	*9.7.7.–	10.10.8.–	12.10.8.6
7.7.7.11	9.X.5.–	*11.7.5.–	13.9.7.7
			13.11.9.7

In introducing the subject of the integrity of the formula we suggest that line D is, with certain exceptions to be noted below, a criterion of the really essential character of any formula. Development of the suggestion follows, under headings of the separate terminations of this line.

13. Rare. The connotation of this termination is that the distal area of the whole palm is figured by a generally transverse series of ridges. The disturbances of ridge direction associated with the presence of patterns occur independently of this generally transverse direction. Owing to the rarity of termination 13 variations in other symbols of the formulae are but scantily exemplified in the known palms. It is obvious that such variations are in part limited by the course of line D, which renders impossible the termination of any line in positions 1 to 5 inclusive.

12. Rare. This termination is a transition between the likewise infrequent position 13 and the very common 11, succeeding. In fusing with line A, the course of line D again precludes the flowing of lines B and C to the ulnar and proximal margins. Thus, except for the slight restriction on the radial side imposed by position 12, the distal part of the palm is associated with a transverse system of ridges. Note that this system necessarily forms a gentle arch with its limbs related to digits II and IV; this may be considered equilibrium of the transverse alignment, at least the equilibrium registered by digital relations. Imbalance toward the radial side becomes 13, and in the other direction, 11.

It is doubtful that an imbalance in the radial direction can proceed very far, owing to the apparent constancy of ridge courses over the thenar eminence and into the first interdigital interval. On the contrary, imbalance in the ulnar direction is of almost invariable occurrence and its progressive ulnar migration is important in the following discussion. At this point it should be noted that the steps in migration are signified by the fixed landmarks provided by the numbered intervals in the scheme of formulation. It is possible that further refinement, directed toward seriation of the terminations on the basis of ridge counting, would yield results justifying the additional labor, although this procedure has not been followed out.

11. Common. Termination of line D in position 11 signifies migration of the distally discrete palmar configurations, a migration which removes digit II from the zone of particularized transverse alignment. Even though there may be an interdigital pattern in relation to the second interdigital interval (as 11.X.7.11; 11.9.7.11) the courses of ridges proximally from this region would be in lines as indicated by terminations 1 to 5 inclusive. While no termination 6 has been found for line A when D opens at 11, it is conceivable that such might occur, through "multiplication" of ridges in the second interdigital area. If such a formula as 11.–.–.6 should be found it would have the same value as 12.–.–.6. The same statement should be applied to other formulae admitting a like relation of radial-ulnar extent of transversality.

10. Fairly common. Position 10 is but a further extension of the tendency toward ulnar shifting of the particularized distal zone, intermediate between 11 and 9. The position includes all formulae in which the symbol 10 is recorded for line D, and in addition some in which the line terminates in other positions (7.7.6.–; 7.7.7.–; 7.X.7.–; 7.9.7.–; 7.10.8.–; 9.7.6.–; 9.7.7.–; 9.X.7.–; 9.9.5.–; 9.9.6.–; 9.9.7.–; 9.10.8.–).

9. Common. Position 9 limits the zone of distal transversality to the regions of digits IV and V. It seems probable that such a formula as 7.9.5.– should be related to position 9.

8. Infrequent. Includes all listed formulations in which D terminates as indicated by 8, also 7.6.–.– and probably 7.7.5.–.

7. Common. Includes all formulae beginning with 7 except those noted above under 10, 9, and 8. Together with the types 8, X, and 5, position 7 is associated with the progressive ulnar shifting, so that finally with 5 the distal zone is throughout covered with ridges slanting proximoulnarwards.

X. Rare. See 7 above.

5. Rare. See 7 above.

1. Unique, but important in illustrating longitudinal ridge direction —a rotation through 90 degrees of the condition begun with 13, and traced progressively through 12, 11, 10, 9, etc.

For the moment confining attention to line D alone, without reference to other characters of the formula, the results of Hasebe and of Wilder for the Japanese again may be called into service as illustration. It will be recalled that Table 2 shows a rather disturbing unlikeness in the incidences of the three typical formulae as recorded by the two observers for their separate collections. Now if the figures of Hasebe and of Wilder relating to line D terminations be similarly compared they may seem at first to be inconsistent likewise. The results are compared in Table 4.

TABLE 4.

PERCENTILE INCIDENCES OF THE SEVERAL LINE D TERMINATIONS IN TWO COLLECTIONS OF JAPANESE AS RECORDED BY HASEBE ('18) AND BY WILDER ('22).

Position	Hasebe	Wilder
6	—	0.7
7	36.6	26.9
X	1.3	—
8	0.7	13.1
9	31.9	22.8
10	1.8	10.0
11	27.7	26.2
12	—	0.25

Upon examining Table 4 with critical attention to possible technical differences in the interpretations of the two observers it becomes evident that the variation may be absorbed with appropriate combinations of certain terminations. The figures suggest that the distinctions possibly erected by technical variation are localized in the discrimination between 7 and 8, and between 9 and 10. It should be pointed out that discrimination in favor of one or the other in each of the pairs of terminations may actually occur (see Wilder and Wentworth, p. 158), with probable individual tendencies in the direction of judgment.[2] As a comment supporting the statement, it may be noted that in Miyake's series of 268 Korean palms not a single instance of position 8 or 10 is recorded for line D (see his Table 4). Combinations of the terminations

[2]There are still other features in palmar dermatoglyphics of which the interpretations are possibly susceptible to such "personal error." In collating the interpretations of several workers, as for comparison of different races, this element of error should be recognized. At present there is no means of identifying error except as it is an obvious associate of determinations involving judgment or unstandardized choice. It is hoped that a collaborative study of the question, now in progress, may yield data by which sources of error are not only identified more specifically but minimized through suitable corrections. The study is being approached through the interpretations of six observers (Cummins, Keith, Midlo, Montgomery, H. H. Wilder, and I. W. Wilder) who are working independently with identical sets of palm prints.

are indicated therefore, in order that such points of variation may be corrected. It should be kept in mind, too, that the direction of ridges is a continuously graded variable and that assortment of its grades must be regulated by the guide of frequency as well as with precaution to obviate vitiation by personal error.

Suggested by the frequencies of the three typical or characteristic formulae (7.5.5–; 9.7.5.–; 11.9.7.–), the terminations of line D are grouped about three types. The types are designated 7, 9, and 11—type 7 including not only position 7 but also 8, X, and 5, type 9 including position 10 as well as 9, and type 11 embracing positions 11, 12, and 13. With this assortment the previously unlike figures for two collections of Japanese approximate uniformity, as shown in Table 5. Miyake's figures for the Koreans, disposed in like manner, are added to the table for comparison.

TABLE 5.

Percentile Incidences of Line D Terminations, as Assorted in Three Types, in Hasebe's and Wilder's Collections of Japanese and in Miyake's Series of Koreans.

Type	Japanese, Hasebe	Japanese, Wilder	Koreans, Miyake
7	38.6	40.7	39.9
9	33.7	32.8	32.8
11	27.7	26.4	27.2

Tests with collections of racial material indicate that groupings made with line D as the only criterion are dependable, although as mentioned above an occasional formula is not allied with the type denoted by its line D alone. Such aberrations are in large measure corrected by the combinations, and those which are not so corrected are practically negligible on account of infrequency. However, a collection of complete formulae may be scanned for their *combinations*, these being grouped about types 7, 9, and 11 as are the line D terminations. The result of this procedure applied to the Japanese material follows in Table 6, which should be compared with Table 5, in which line D alone is concerned, and particularly with Table 2, wherein the main line formulae are grouped by the customary method. Whatever may be the chosen object of comparison, line D or the entire formulae, rigorous attention should be exercised properly to identify exponent terminations of line D. When there is an alternative between two courses (e.g., $7^{(10)}$) the more radial termination is the one which should govern assignment in grouping.

TABLE 6.

Percentile Distribution of the Complete Main Line Formulae in Two Collections of Japanese (Hasebe; Wilder) in Accordance with Grouping into Three Types.

Type	Hasebe	Wilder
7	36.7	40.2
9	35.5	33.3
11	27.7	26.4

TABLE 7

Palmar Main Line Formulae, 100 Males. Series I

Act. No.	RIGHT	LEFT	Acc. No.	RIGHT	LEFT
1	11. 9. 7. 5. C	11. 9. 6. 5. C	165	11. 10. 8. 5. C	11. 0. 0. 5. C
2	9. X. 7. 5. C	7. 7. 5'. 1. C	168	11. 9. 7. 5". C	11. 9. 7. 5'. C
6	7. 9. 5". 5'. C	7. X. 5". 5. C	170	11. 9. 7. 5. CC^h	11. 9. 7 5'. C
7	11. 9. 7. $5''^d$ C	11. 9. 7. 5'. C	176	9. 7. 5". 4. C	9. 7. 5'. 3. C
8	11. 9. 7. 5". C	11. 9. 7. 5'. C	177	8. 6. 5". 3. C	8. 6. 5". 3. C
10	8. 6. 5". 5. C	9. 7. 5". 5. C	180	8. 6. 5". 5. C	10. 9. 6. 5. C
11	10. X. 6. 5. C	8. 7. 5". 3. C	181	11. 10. 8. 4. C	7. 5". 5". 4. C
14	7^d. 9. 5". 3. C	7. 5". 5'. 3. C	187	11. 9. 7. 5. C	10. 7. 6. 3. C
15	11. 9. 7. 5'. C	9^d. X. 5". 5. C	188	11^d. 9. 7. 5'. C	11^d. 7. 7. 5. C
18	9. 7. 5". 5. C	7. 5". 5". 3. C	190	11. 9. 7. 5'. C	9. 9. 5". 5. C
38	9. 7. 5". 5. C	11. 9. 7. 5. C	200	11. 9. 7. 5'. C^h	9. 7. 5". 5. C^h
41	9. 7. 5". 5. C	7. 6. 5". 3. C	215	11. 9. 7. 5". C^h	9. X. 5". 5'. C^h
44	11. 9. 7. 3. C	7. 5". 5". 3. C	217	9. 7. 5". 5. CC^h	9. 9. 5". 5. C^h
45	11. 9. 7. 5'. C	9. 9. 5". 5. C	218	9. 0. 5". 5. C	9. 0. 5". 5. C
46	11. 9. 7. 5'. C	11. 9. 7. 5'. C	221	11. 9. 7. 5'. C	11. 10. 8. 5'. C
47	8. 6. 5". 4. C	7. 5". 5". 3. C	222	9. 7. 5". 5. C	7. 5". 5". 5. C
50	9. 7. 5". 5. C	9. 7. 5'. 4. C	226	7. 9. 7. 5'. C	10. X. 6. 5. C
52	11. 9. 7. 5'. C^h	9. X. 5". 5'. C	229	11. 10. 8. 5. C	11. X. 7. 5. C
53	11. 9. 7. 5. C	11. 9. 7. 3. C	231	9. X. 5". 4. C	11. 9. 7. 3. C
54	9. 7. 5". 5. C	9. 7. 5". 5. C	246	7. 5". 5". 3. C	7. 5". 5'. 5. C
55	11. 9. 7. 5. C	11. X. 7. 3. C	255	11. 9. 7. 5. C	9. 9. 5". 3. C
56	7. 5". 5'. 5. C	7. 5". 5". 2. C	256	9. 7. 5". 3. C	7. 5". 5'. 2. C
57	10. 9. 5". 5'. C^h	7. X. 5". 3. C	260	9. 7. 5". 4. C	9. 7. 5". 3. C
58	9. 7. 5". 3. C	9. 7. 5". 3. C	261	9. 7. 5". 3. C	7. 5". 5'. 3. C
62	11. 9. 7. 5". CC^h	9. X. 5". 5'. C^h	262	9. 7. 5". 3. C	8. 6. 5". 3. C
67	9. 7. 5". 3. C	9. 7. 5". 3. C	263	10. 9. 6. 5. C	9. X. 5". 3. C
69	9. 7. 5'. 3. C	9. X. 5". 3. C	265	10. X. 6. 4^d. C^h	7. 7. 5". 5. C^h
70	11. 9. 7. 5'. C^h	11. X. 7. 5. C	266	11. 9. 7. 5. C	9. 9. 5". 3. C
71	11. 9. 7. 5. C	11. 7. 7. 5. C	267	11. 9. 7. 5. C	11. 7. 7. 4. C^h
72	9. 9. 5". 5. C	9. 7. 5". 5'. C	269	11^d. 9. 7. 5'. C	9^d. 7. 5". 5. C^h
85	9. 7. 5". 5. C	9. 7. 5". 3. C	270	9. 7. 5'. 3. C	9. 7. 5". 3. C
86	11. X. 7. 5'. C	11. 7. 7. 5'. C	271	11. 9. 7. 5'. C^h	11. 9. 7. 5. C^h
88	8. 6. 5". 5'. C	7. 5". 5". 5. C	273	11. 9. 7. 5'. CC^h	11. X. 7. 5'. C
98	10. X. 6. 5'. C	9. X. 5". 5'. C	275	11. 9. 7. 5. C	11. X. 7. 5. C
108	9. X. 5". 4. C^h	7. 5". 5'. 2. C^h	276	10. 9. 6. 5. C^h	9. X. 5". 5'. C^h
109	10. 0. 6. 5. C	10. X. 6. 4. CC^h	277	11. 9. 7. 5'. C	10. 7. 6. 3. C
110	11. 9. 7. 5'. C	11. X. 7. 5'. C^h	285	11. 9 7. 5'. C	11. 9. 7. 5'. C
120	11. 9. 7. 5'. C	8. 6. 5". 4. C	287	11. 9. 7. 5. C	11. X. 7. 5. C^h
129	11. 10. 8. 5". CC^h	11. X. 7. 5'. C^h	288	9. 7. 5". 5. C	9. 7. 5". 5. C
130	11. 9. 7. 5. C	10. X. 6. 3. C	289	7. 5". 5". 3. C	7. 5". 5". 3. C
132	11. X. 7. 5. C	9. 7. 5". 3. C	292	9. 7. 5". 5. C	9. X. 5". 5. C
133	11. 9. 7. 5^d.	9. X. 5". 5. C^h	293	11. 9. 7. 5'. C	9. 7. 5". 5. C
141	7^{11}. 9. 7. 5'. C	7^{10}. X. 7^6. 5'. C	294	9. 7. 5". 5 CC^h	9 7. 5". 3. C^h
144	11. 0. 7. 5'. C^h	11. 0. 7. 5'. CC^h	295	11^d. 9. 7. $5''^d$. C	9^d. 9. 5" 5'. C
147	11. 9. 7. 5. C	7. 7. 6. 3. C	500	11. 9. 7. 5. C.	10. 7. 7. 3. C
148	11. 9. 7. 5'. C^h	11. X. 7. 5'. C^h	501	11. X. 7. 5'. CC^h	11. 7. 7. 5'. CC^h
149	8. 7. 5". 5'. CC^h	7. 5". 5". 5. CC^h	502	11. 9. 7. 5'. C	11. 9. 7. 4. C
159	10. 7. 6. 5'. C	7. 5". 5". 5. C	503	7. 5". 5". 4. C^h	9. X. 5". 3. C^h
160	10. 9. 6. 5. C	10. 7. 6. 5. C	504	11. X. 7. 5. C	9. X. 5". 1. C
162	12^d. 9. 7. 6. C^h	11^d. 9. 7. 5'. C^h	505	7. 5". 5". 5. C	9^7. 7. 5". 4. C

TABLE 7
Palmar Main Line Formulae, 100 Males. Series II

Acc No	RIGHT	LEFT	Acc. No	RIGHT	LEFT
616	11. 9. 7. 3. C	11. 7. 7. 1. C	693	11. 0. 0 5′. C	9. X. 5″. 5. C
618	11. 9. 7. 5′. C^h	7. 5″. 5′ 3. C	695	10. X. 7. 5. C	11. 7 7. 3. C
619	11. 9. 7. 5′. CC^h	11. X. 7. 5″. CC^{h}C^h	696	7$^{(11)}$. 9. 7. 5′. C	7$^{(10)}$. 9. 6. 3. C
620	11. 9. 7. 5′. C	9. X. 5″. 3. C	698	11 9 7 5 C	9. X. 5″. 3. C
621	11. 9. 7. 5′. C^h	11. 9. 7. 5′$^{(11)}$. C^h	699	11 9. 7. 5′. C	11. X. 7. 5. C
622	7. 5″. 5″. 4$^{(11)}$. C^h	7. 5″. 5′. 1. C^h	700	10. 9. 7. 5. C	9 7. 5″. 5 C
625	11. 9. 7. 5. C	9. 7. 5″. 3. C	701	11. 9. 7 5′. C	9. 7. 5″. 2. C
626	11. 9. 7. 5″$^{(11)}$. C	10. 9. 6. 5″. C	702	11. 9. 7. 5′. CC^h	11. 9. 7. 5′. CC^h
628	11. 9. 7. 5″. C	11. 9. 7. 5′. C	703	11. 9. 7. 5. C	9. 7. 5″. 3. C
629	11. 10. 8. 5′. C^h	11. 9. 7. 5. C^h	704	7. 5″. 5″. 5. C	7$^{(9)}$. 7. 5″. 5. C^h
630	11. 9. 7. 4. C	11. X. 7. 3. C	705	11. 9. 7. 5′. C	11. 9. 7. 5″. C
631	11. 10. 8. 5″. C	9. 0. 5″. 5′. C	706	9. 7. 5″. 4. C	11. X. 7. 1. C
632	11. 9. 7. 5′. C^h	9. 0. 5″. 5. C^h	707	11. 9. 7. 3. C	9. 7. 5″. 3. C
633	9. 7. 5″. 3. C	9. 7. 5. 1. C	708	7. 5″. 5″. 5′. C	7$^{(11)}$. 9. 7. 5′. C
634	11. 9. 7. 5. CC^h	9. 7. 5″. 4. CC^h	709	11. 10. 8. 5. C	11. 9. 7. 3. C
635	11. 10. 8. 5″. C	11. 0. 7. 5′. C	712	11. 9. 7. 5. C	7. 5″. 5″. 3. C
636	11. 9. 7. 5. C^h	9. 0. 5″. 1. C	713	9. X. 5″. 5. C	9. 9. 5″ 3. C
637	11. 0. 7. 3. C	8. 7. 5″. 3. C	714	11. 9. 7. 5″. C	11. X. 7. 5. C
640	11. 9. 7. 3. C	9. 7. 5″. 5. C	715	11. 9. 7. 5′. C^h	11. 7. 7. 5. C^h
642	11. 9. 7. 5′. C	11. X. 7. 3. C	717	9. 9. 5″. 5. CC^h	7. 5″. 5′. 3. C^h
648	11. X. 7. 4. CC^h	10. 7. 6. 3. CC^h	718	11. 9. 7. 5. C	11. 7. 7. 1. CC^h
649	9. 7. 5″. 5. C	7. 5″. 5′. 3. C	720	11. 9. 7. 5′$^{(11)}$. C	9. X. 5″ 5′. C
650	9. 7. 5″. 5. C^h	7. 5″. 5′. 3. C	721	9. 7. 5″. 1. C	9. 7. 5″ 2. C
652	11. 9. 7. 5. C	9. 9. 5″. 3. C	724	9. 7. 5′. 5. C	7. 5″. 5′. 3. C^h
653	9. 7. 5″. 3. C	7. 5″. 5″. 4. C	725	11. 10. 8. 5′. C	10. 9. 5″. 3. C
654	11. 9. 7. 5. C^h	11. 9. 7. 1. C^h	728	11. 11. 9. 5. C^h	11$^{(7)}$. 9. 7. 1. C
655	11. 9. 7. 5′. C^h	11. 9. 7. 5. C^{h}C^h	729	11. 0. 7. 5. C	11$^{(7)}$ 9. 7. 4. C
656	8. 6. 5′. 3. C	9. 7. 5′. 3. C	730	7. 5″. 5″. 5. C	7. 9. 5′. 3. C
657	7. 9. 7. 5″. C^h	7. X. 5″. 5′. C	731	11$^{(7)}$. 9. 7. 5. C^h	11. 0. 7. 4. C^h
660	11. 9. 7. 5.. C	11. 7. 7. 5. C	732	11. 9. 7. 3. CC^h	11. 9. 7. 1. CC^{h}C^h
661	9. 9 5″. 3. C	9$^{(7)}$. 9. 5″. 3. C	733	7. 5″. 5′. 4. C	7. 5″. 5′. 3. C
662	10. 9. 5″. 3. C	9. 7. 5″. 3. C	734	11. 9. 7. 3. C	11. 9. 7. 3. C
663	11. 9. 7. 5″. C	11. X. 7. 5′. C	735	10. 7. 6. 3. C	9. 7. 5″. 1. C
665	11. 9. 7. 5. C	9$^{(7)}$. X. 5″. 5. C	736	9. 7. 5. 3. C	9. 7. 5″. 3. C
666	8. 6. 5″. 4. C	9. 7. 5′. 3. C	737	9. 9. 6. 5. CC^h	7. 5″. 5″. 1. CC^h
667	11. 9. 7. 5. CC^h	9. 9. 5″. 5. CC^h	738	9. 7. 5″. 3. C	9. 9. 5″. 1. C
668	11. 9. 7. 5. C^h	9. 7. 5″. 5. C	739	11. 9. 7. 5″. C	11. 9. 7. 5. C
670	11. 9. 7. 5′. CC^h	7$^{(10)}$. 9. 6. 3. C	740	7. 5″. 5″. 4. C	9. 7. 4. 1. C
672	11. 9. 7. 5′. CC^h	10. X. 7. 5′. C	742	11. 9. 7. 5′. CC^h	9. 7. 5″. 5. CC^h
674	9. 7. 5″. 3. C	7. 5″. 5′. 1. CC^h	743	9. 9. 5″. 1. C^h	9. 7. 5′. 1. C^h
675	7$^{(9)}$. 0. 5″. 5′. C	7$^{(11)}$. 9. 7. 5. C	744	11. 9. 7. 5′. C	11. 9. 7. 4. C
677	9. 7. 5″. 4. C	10. X. 7. 3. C	745	9. 7. 5″. 3. C	9. 9. 5″. 3. C
678	9. 7. 5″. 3. C	9. 7. 5″. 3. C	747	11. 9. 7. 5′. C	9. X. 5″ 5′. C
680	11. X. 7. 5′.- C	10. 7. 7. 3. C	748	11. 9. 7. 5. C	11. X. 7. 2. CC^h
681	7. 9. 7. 4. C	7. 7. 5″. 3. C	750	9. 7. 5″. 3. CC^h	9. 7. 5″. 3. CC
684	9. X. 5″. 5. C	9. 7. 5″. 3. C	751	11. 9. 7. 4. C	9. 9. 5″. 1. C
685	11. X. 7. 5. C	11. 7. 7. 5. C	753	11. 9. 7. 5. C	9. 7. 5″. 3. C
686	11. 9. 7. 5′. C	10. 9. 6. 5. C	758	11. 9. 7. 5. C	10. X. 6. 3. C
691	11. 9. 7. 5″. CC^h	10. 9. 7. 1. C^h	759	10. 7. 6. 4. C	7. 5″. 5′. 3. C
692	9. 7. 5″. 5. C	9. 0. 5″. 5. C	760	11. 0. 7. 5. C	9. X. 5″. 3. C

RESULTS

A list of the main line formulae in 200 male European-Americans is presented in Table 7.

The formulae listed in Table 7 are to be examined first for the occurrence of the several terminations of each of the main lines. Tables 8, 9, 10, and 11 carry the data relating to this feature, and except for the special consideration of lines C and D they will be passed without comment.

TABLE 8.

Terminations of Line A, Stated in the Percentile Occurrence in Each Series of 100 Individuals (200 Palms).

Position	Male		Female		Average
	Series I	Series II	Wilder, 1913	Wilder, 1918	
1	1.0	9.5	1.0	1.0	3.1
2	1.5	2.0	5.5	9.5	4.6
3	22.0	29.5	15.5	20.5	21.8
4	7.5	8.0	9.0	10.0	8.6
5	67.5	51.0	69.0	59.0	61.6
6	0.5	—	—	—	0.1

TABLE 9.

Terminations of Line B, Stated in the Percentile Occurrence in Each Series of 100 Individuals (200 Palms).

Position	Male		Female		Average
	Series I	Series II	Wilder, 1913	Wilder, 1918	
3	—	—	0.5	0.5	0.2
4	—	0.5	—	—	0.1
5	49.0	43.5	39.5	47.0	44.7
6	8.5	4.5	15.5	13.5	10.5
7	39.5	48.0	40.0	33.5	40.2
8	2.5	2.5	4.5	5.0	3.6
9	—	0.5	—	0.5	0.2
0	0.5	0.5	—	—	0.2

TABLE 10.

Terminations of Line C, Stated in the Percentile Occurrence in Each Series of 100 Individuals (200 Palms).

Position	Male		Female		Average
	Series I	Series II	Wilder, 1913	Wilder, 1918	
5	10.0	9.0	10.5	8.5	9.5
6	4.5	1.0	4.5	11.5	5.3
7	26.0	25.0	33.0	33.0	29.2
9	35.5	44.0	36.0	26.5	35.5
10	2.5	2.5	4.0	5.0	3.5
11	—	0.5	—	0.5	0.2
X	18.5	12.5	12.0	15.0	14.5
0	3.0	5.5	—	—	2.1

TABLE 11.

Terminations of Line D, Stated in the Percentile Occurrence in Each Series of 100 Individuals (200 Palms).

Position	Male		Female		Average
	Series I	Series II	Wilder, 1913	Wilder, 1918	
7	15.5	15.0	13.0	10.5	13.5
8	5.5	1.5	4.5	12.0	5.8
9	30.0	30.5	25.5	26.0	28.0
10	8.5	6.5	16.0	13.5	11.1
11	40.0	46.5	41.0	38.0	41.3
12	0.5	—	—	—	0.1

Among the more conspicuous variations of main lines is the condition in which the line is entirely lacking, together with its triradius (formulated, O), or extends for but a short distance proximally from its triradius of origin, neither reaching the palmar margin nor fusing with another main line (formulated, X). This variation is almost confined to line C, and it is its occurrence with regard to this line which will be next considered. Table 10 carries the occurrence of O and X conditions of line C in our two series of males and in Wilder's two series of females. The incidence of both varieties in males is 19.7%, and in females, 13.5%. As stated above, Wilder's record of the incidence in females is 13.5% (his Table 15b, '22), and this figure agrees with a computation from the list of main line formulae in Table 14 of the same paper. It will be noted that neither of Wilder's two tables shows an instance in which line C is indicated as wanting; all examples are formulated in position 8 (=X). This observation is confirmed by the two original tables ('13; '18) which are amalgamated as Table 14 in the 1922 paper. That there may be some error in the tabulations is suggested by the following extract from Wilder's paper of 1916.

"In the hands of 145 white persons (mostly Smith College students) a complete loss of line C, with its triradius, was found in both hands in four cases; in the right alone in five; and in the left alone in eight. That is, out of 145 individuals, no less than 17 of them showed a complete loss of the C line in one or both hands; or, put another way, out of 290 separate hands 21 were thus marked. In addition to these, nine more individuals possessed in one hand a very short and straight C line, ending in a loop, and as these were none of them duplicate individuals with any of the above or with each other, this gives a total of 26 individuals out of the 145 in which the term x (=8) occurs in one or both of the hand formulae as a designation of line C; that is, nearly 18%."

The comparative figures of Wilder and ourselves are rendered still less substantial by the possibility of inconsistent formulations. It is conceivable that we have formulated under the caption X some lines

which Wilder would have traced to positions 7 or 9; our lower incidences of these interdigital positions, especially 7, lead to such suspicion. Whatever may be the solution of this elusive question, it is self-evident that the figures for X and O are of doubtful value.

In a foregoing section devoted to discussion of the significance of the main line formula it is stated that line D may be the truly essential member of the formula. Following this suggestion, Table 11 should be examined with especial attention. As the data stand there are certain discrepancies in the figures recorded for the four series of 100 individuals each. Some degree of variation is to be expected in comparing occurrences in series of this size; yet apart from this there is a source of error inherent in the formulation. Amalgamation of terminations 7 and 8, and of 8 and 9 have been suggested. Applying the stated combinations to the data of Table 11, the figures shown in Table 12 are obtained.

TABLE 12.

Percentile Incidences of Line D Terminations in Four Series of European-Americans, Each Comprising 100 Individuals. Terminations are Assorted in the Three Types as Defined in the Text. For Illustration of Racial Distinction Compare with Table 5.

Type	Male		Female		Average
	Series I	Series II	Wilder, 1913	Wilder, 1918	
7	21.0	16.5	17.5	22.5	19.3
9	38.5	37.0	41.5	39.5	39.1
11	40.5	46.5	41.0	38.0	41.5

The terminations of Line D listed in Table 12, with averages of 19.3%, 39.1%, and 41.5% for the three types (7, 9, and 11 respectively) may be taken as representative of the European-American configurations. As an illustration of the comparative application of such data reference should be made to Table 5, wherein the corresponding Japanese and Korean characters are detailed.

Whether any weight is to be attached to the variations obtaining in the figures for the four series is a matter of question. Of the factors which suggest themselves as responsible for the variation there may be mentioned especially the heterogenous nature of the racial material and the relatively small size of the compared series. Sexual distinctions appear to be ruled out by the variations displayed within one sex, comparing the two random series of each. There remains the possibility of inadequacies in the method of formulation and subsequent comparison. Apart from the question of whether the general method of comparison is valid, an item of frank error in the preliminary formulation should be pointed out. In compiling Tables 11 and 12 it was considered advisable to disregard for the moment an injunction mentioned earlier with reference to exponent terminations of line D. It will be recalled that in

cases of exponent terminations the more radial one is regarded as the indicator of the essential character of the ridge courses. However, and contrary to the expectation of their occurrence in collections of this size, exponents are not indicated in Wilder's tables for females. It is assumed that the initial symbol for line D must have been recorded in every case, thus calling for the same procedure in the males. (It is altogether likely that individual observers would vary in their emphasis on initial symbols; if this be true, error is injected.) Only infrequent cases of dual terminations of line D are found in the male series, as may be seen by comparison of Tables 13 and 14, the more radial termination being emphasized in Table 14, and the initial symbol in Table 13.

Bimanual distinctions in the main lines have been long recognized (see especially Keith). Let us then turn to the bimanual distribution of the line D terminations, which from our present viewpoint seem to portray the primary object of comparison of main lines. Table 13 gives the result of separating right and left hands, with the 200 males and 200 females listed separately. Table 14 shows, for the males only, the result of strict attention to exponent terminations of Line D.

TABLE 13.

TERMINATIONS OF LINE D, SHOWING THE PERCENTILE INCIDENCES OF THE 7, 9, AND 11 TYPES IN RIGHT AND LEFT HANDS SEPARATELY (200 MALES; 200 FEMALES).

Type	Male		Female		Both sexes	
	Right	Left	Right	Left	Right	Left
7	13.5	24.0	15.5	24.5	14.5	24.2
9	30.0	45.5	37.5	43.5	33.7	44.5
11	56.5	30.5	47.0	32.0	51.7	31.2

TABLE 14.

TERMINATIONS OF LINE D IN 200 MALES, SHOWING THE PERCENTILE INCIDENCES OF THE 7, 9, AND 11 TYPES IN RIGHT AND LEFT HANDS SEPARATELY. IN COMPILING THIS TABLE THE MORE RADIAL TERMINATION WAS SELECTED IN ALL FORMULAE SHOWING EXPONENT TERMINATIONS; THE FIGURES SHOULD BE COMPARED WITH THOSE FOR MALES IN TABLE 13, WHEREIN IT IS THE INITIAL SYMBOL IRRESPECTIVE OF RADIAL-ULNAR CRITERIA.

Type	Right	Left
7	12.0	21.0
9	30.5	47.5
11	57.5	31.5

The two foregoing tables (13 and 14) show clearly the recognized ascendancy of the right hand in the possession of a more radially extended transversality. In the right hand the occurrences of the three types stand in regularly ascending progression, i.e., 7–9–11, while in the left hand the seriation is 9–11–7.

Now turning to the main line combinations, attention is directed first to the customary assortment in which only the three typical or characteristic formulae are concerned. Their incidences, established by the procedure outlined by Wilder ('22), add nothing noteworthy to records hitherto in the literature except in the accentuation of the characters previously accepted as distinctive of the Caucasian palm. The figures are recorded in Table 15.

TABLE 15.

Percentile Incidences of the Three Typical or Characteristic Formulae in 800 Palms. Indicated Separately for Each of the Four Random Series of 200 Palms Each.

Formula	Males		Females		Average
	Series I	Series II	Wilder, 1913	Wilder, 1918	
7.5.5.–	10.0	9.0	10.0	8.0	9.25
9.7.5.–	26.0	24.5	20.0	21.5	23.0
11.9.7.–	34.0	40.0	31.5	24.0	32.37

Next considering the entire series of main line formulae, assembled in accordance with the suggested revised grouping, we find the four series more nearly uniform. The disparities are such as to accentuate the recognized Caucasian characteristic, and as in the preceding development of line D alone, the accentuation is most marked in our Series II. The results of the revised grouping are arrayed in Table 16.

TABLE 16.

Percentile Distribution of the Complete Main Line Formulae in 800 Palms, in Accordance with Grouping into Three Types.

Type	Males		Females		Average
	Series I	Series II	Wilder, 1913	Wilder, 1918	
7	18.5	11.5	16.0	20.5	16.6
9	41.0	40.5	43.0	41.5	41.5
11	40.5	48.0	41.0	38.0	41.9

Palmar Patterns

definition

A "pattern" is a localized system of ridges in which concentric designs, loops, and other figures are effected by abrupt ridge curvatures. Patterns stand in contrast to "open fields," where ridges pursue straight or only gently sweeping courses. On the palm the ideal or complete complement consists of six patterns, existing as islands in the midst of open fields of varying course. There are four interdigital patterns, located in proximal relation to the interdigital intervals, and a thenar and a hypothenar pattern located on the proximal areas of the respective eminences. It is but rarely that an individual palm may be found in which all six patterns occur; variations exist both in the number of

patterns which are represented and their types. In the absence of a pattern the area which is its morphological site is characterized by an open field. Comparative studies are concerned with statistical frequencies of patterns, and to a certain extent with their types. The recording of patterns has been placed upon a basis of formulation by Wilder ('22), whose method is recounted below together with some minor additions.

METHOD OF FORMULATION

Order of symbols. In Wilder's formulation the order followed is: carpal triradius—thenar and first interdigital patterns—hypothenar pattern—second, third, and fourth interdigital patterns. The writers adhere to this order but transfer the carpal triradius to the main line formula.

Significance of the symbols. Each pattern is assigned a symbol, as explained below, and the occurrence of a symbol in the statement of a formula signifies only that the pattern which it represents is present. Qualifying symbols may be added to the primary symbol of a pattern in order to designate something of its character. Where no symbol is indicated for an individual pattern the site on which this pattern might be expected to occur is occupied by an open field.

A qualifying symbol of general application. Rather frequently there occur areas which are neither typical open fields nor true patterns. They are removed from the class of typical open fields in displaying ridge aberrancies which possess some relationship to the dispositions characterizing patterns, often, for example, being in the form of abrupt convergences toward a common point of a series of ridges which elsewhere course parallel. When such areas of ridge disturbance are located on sites that might otherwise bear patterns of the normal series they are interpreted as pattern rudiments, and as such are indicated in the formula by an "r" (for rudimentary) following the symbol of the particular pattern.

Thenar and first interdigital patterns. Wilder indicates the presence of either or both of these patterns by the symbol "Th." Since the individual identities of the two patterns are fairly well established by their positions on the thenar eminence we have sought to distinguish their separate occurrence by two symbols, "Th" and "I" respectively for the thenar and first interdigital.

Hypothenar pattern. "This is commonly a loop, opening upwards (a), outwards, i.e., ulnarwards (b), or downwards and inwards, radially (c), and, as the pattern is naturally called H, this gives for the three forms,

H^a, H^b, and H^c. There may be also the whorl (H^w) and the S-shaped figure (H^s), and this latter may be spread out so completely as to form two loops, facing in opposite directions." (Wilder, '22.) It has been necessary to add three elements to this series of symbols in description of further variations. First, several examples of double patterns require recognition; being duplex in their nature these patterns are signalized by double symbols which represent the types of the two elements, as H^aH^b. A second variant is an arch with its convexity facing ulnarwards (H^{arch}), and a third is a very low loop opening ulnarwards (H^{carpal}).

Second, third, and fourth interdigital patterns. In formulation the mere presence of these patterns is indicated by the numerals, 2, 3, and 4, respectively, and there is no further characterization of the types except for the fourth interdigital pattern. In the case of the pattern in question three designations are used, namely, 4 (unqualified), 4^t, and $4'$. The symbol 4, standing alone, represents a loop enclosed by the distally recurved line D. If there be a triradius in relation to the pattern, a loop or a whorl, its presence and that of the pattern are recorded as 4^t. When there is a "false" pattern lying in the radial portion of the area intervening between the digital triradii c and d, that is, a loop enclosed by line C and invariably lacking an associated triradius, it is distinguished as $4'$.

An abrupt termination of line C after a short proximal course allows a confluence of the ridges of the third and fourth interdigital areas. The configuration resembles the tented arch of the apical digital patterns. This condition is expressed by Wilder as $3+4$. Even though line C may be incorporated into a pattern which is definitely within one or the other interdigital area, frequently there is a wide coalescence of the two interdigital areas, with the same broad looped configuration as when line C is short. Inasmuch as the course of line C in such cases does not modify the aspect of the configuration as a whole, all broad confluences are designated herein by the symbol $3+4$.

In each of several palms there occurs a proximal triradius between the third and fourth interdigital patterns (as in Fig. 46, Wilder and Wentworth). Its presence is indicated by the letter d, following the formulation of interdigital patterns.

RESULTS

In Table 17 the entire series of 400 palmar pattern formulae are listed in the order of their accession numbers. The condensed data are shown in Table 18, which reveals no noteworthy differences from the findings previously reported by Wilder.

TABLE 17

Palmar Pattern Formulae, 100 Males. Series I

Acc. No.	RIGHT			LEFT			Acc. No.	RIGHT			LEFT		
	Th I	HYP.	INTERDIG.	Th I	HYP.	INTERDIG.		Th I	HYP.	INTERDIG.	Th I	HYP.	INTERDIG.
1	—	—	3	—	—	3,3+4	165	—	H^w	$3,4^t$	(I_r)	H^a	$(3^t_r),(4^t_r)$
2	—	—	3+4	(ThI_r)	—	4,4′, d	168	—	—	3	—	—	$(3_r),3+4$
6	—	—	$3,3+4,4^t$	—	—	$3+4, 4^t$	170	—	H^b	3,3+4	—	H^b	$(3_r),3+4$
7	(Th_r)	—	$2^t,3,(4^t_r)$	(ThI_r)	—	$3,3+4,4^t$	176	—	H^a	4′	—	H^a	4′
8	—	H^a	3	—	H^a	3,3+4	177	—	—	4	—	—	4
10	—	—	4	—	—	$4',(4^t_r)$	180	—	—	4	—	—	3
11	—	—	3+4	—	—	4	181	—	H^a	3	—	H^a	4
14	—	H^a	$3, 4^t$	—	H^a	(4^t_r)	187	—	—	3	—	—	3+4, 4′
15	—	H^a	$(2^t_r),3,(4^t_r)$	—	H^a	$3+4,4^t$	188	—	H^a	$3, 4^t$	—	H^a	$4', 4^t$
18	—	—	4′	—	—	4	190	—	H^a	3,3+4	—	H^a	$(3_r),3+4$
38	—	H^a	4′	—	—	3,3+4	200	—	—	3	—	—	4^t
41	—	H^a	$3+4,(4'_r)$	—	H^a	$3^t,4$	215	—	—	$(2^t_r),3$	—	—	$(2^t_r),(3_r),(4^t_r)$
44	—	—	3	—	—	4	217	—	H^b	4′	(I_r)	—	3,3+4
45	(ThI_r)	—	$2^t,3$	(ThI_r)	—	$3, 4^t$	218	—	H^a	—	—	H^a	—
46	—	H^a	3	—	H^a	3	221	—	H^a	3	—	H^a	3
47	(Th_r)	H^a	4	—	H^a	4	222	—	—	4′	—	—	4
50	—	H^a	4′	—	H^a	4′	226	—	—	$3,4^t$	—	—	3+4
52	—	H^c	3,3+4	(ThI_r)	H^a	3+4	229	—	H^a	3	—	—	3+4
53	—	—	3	—	—	3	231	—	H^a	3+4	—	H^a	3
54	—	—	4′	—	—	4′	246	—	H^a	4	—	—	4
55	—	—	3,3+4	—	—	3+4	255	—	—	3,3+4	—	—	$(3_r),3+4$
56	—	—	4	(I_r)	—	4^t	256	—	H^a	4′	—	H^a	4
57	—	—	$3, 4^t$	—	—	$(3^t_r),4$, d	260	—	H^a	3+4, 4′	—	H^a	3+4, 4′
58	—	—	3+4,4′	—	—	3+4,4′	261	—	—	$3+4, 4^t$	—	—	4
62	—	H^b	3	—	—	3+4	262	—	—	3+4, 4′	—	—	4
67	—	—	3+4,4′	—	H^a	3+4,4′	263	(I_r)	—	3,3+4	I	—	3+4
69	—	—	4′	—	—	3+4	265	—	H^a	$2^t,3+4$	—	—	$3+4,4',(4_r)$,d
70	—	—	3,3+4	—	—	3+4	266	I	—	3	—	—	3,3+4
71	—	—	3	—	—	$3+4,(4'_r)$	267	—	H^aH^b	3,3+4	—	H^a	3+4,4′
72	—	—	$(3_r),3+4$	—	—	4′	269	—	—	$3,3+4,(4^t_r)$	—	—	$4',4^t$
85	—	H^a	$4',(4^t_r)$	—	H^a	4′	270	—	—	4′	—	—	3+4,4′
86	—	—	3+4	(ThI_r)	—	3+4,4′	271	—	—	3	—	—	$(3_r),3+4$
88	—	—	4	—	—	4.	273	—	H^b	3	—	—	3+4
98	—	—	3+4	(ThI_r)	—	3+4	275	—	—	3	—	H^a	3+4
108	—	H^{arch}	3+4	—	—	4	276	—	H^a	3	—	—	3+4
109	—	H^s	3+4	—	H^s	—	277	—	—	3	—	—	3+4,4′
110	—	H^b	3	—		3+4	285	—	—	3	—	—	3,3+4
120	—	H^a	3	—	H^a	4	287	—	H^a	3	—	H^aH^b	3+4
129	—	H^b	3	—	—	3+4	288	—	—	4′	—	H^b	4′
130	—	—	3,3+4	—	—	3+4	289	—	—	4	—	—	(4_r)
132	—	—	3+4	ThI	—	4′	292	—	—	3+4,4′	—	—	3+4
133	ThI	H^w	$2^t,3,3+4$	ThI	—	3+4	293	—	H^a	(3_r)	—	H^a	3+4,4′
141	—	—	$3,4^t$	—	—	$4^t,3+4$	294	—	H^b	3+4,4′	—	—	3+4,4′
144	—	—	2^t	—	H^aH^b	2^t	295	—	—	$2^t,3,4^t$	I	—	$2^t,3,4^t$
147	—	H^c	3	—	—	$3+4,(4'_r),(4^t_r)$	500	—	—	3	(I_r)	—	$3+4,4',(4^t_r)$
148	—	—	(3_r)	—	—	—	501	—	H^b	3+4	—	H^b	3+4,4′
149	—	H^s	4′	—	H^b	4	502	—	H^a	$(2^t_r),3$	—	H^a	$(3_r),3+4$
159	—	H^{arch}	4′,3+4	—	H^a	4	503	—	H^a	4^t	—	—	3+4
160	—	—	3	—	—	3+4,4′	504	—	—	3+4	—	—	$3+4,(4'_r)$
162	—	—	$2^t,3$	—	—	$3,(4^t_r)$	505	—	H^a	4	—	H^a	$4',4^t$

TABLE 17

Palmar Pattern Formulae, 100 Males. Series II

Acc. No.	RIGHT			LEFT			Acc. No.	RIGHT			LEFT		
	Thl	HYP.	INTERDIG.	Thl	HYP.	INTERDIG.		Thl	HYP.	INTERDIG.	Thl	HYP	INTERDIG.
616	—	—	3	—	H^aH^a	3+4, 4′	693	—	—		—	H^a	3+4
618	—	(H^b_r)	3, 3+4	—	—	4	695	—	—	3+4	—	—	3+4, 4′
619	—	(H^b_r)	3, (4_r)	—	H^bH^b	3+4, (4_r)	696	—	—	3, 4^t	—	—	(3_r), 3+4, (4^t_r)
620	—	—	3	—	—	3+4	698	—	—	3	—	—	(3_r), 3+4, (4^t_r), d
621	—	—	3	(I_r)	—	2, (3_r), (4_r)	699	—	H^b	3	—	—	3+4
622	(I_r)	H^w	2, 4	(ThI_r)	H^a	4	700	I	—	(2_r), 3, 3+4	I	—	4′
625	—	—	—	—	—	4′	701	—	—	3	—	—	4′
626	—	—	2, 3, 3+4, 4^t	ThI	—	2^t, (3_r), 3+4	702	—	H^b	3	—	H^b	3
628	—	—	(2_r), 3, (4_r)	—	—	(3_r), 4^t	703	—	H^a	3	—	—	3+4, 4′
629	—	H^s	3	—	—	3, 3+4	704	—	—	4	—	—	3+4, 4′, 4^t
630	—	H^a	3, 3+4	—	H^a	3+4	705	—	—	(3_r), (4^t_r)	—	H^a	3
631	—	H^a	3	—	H^a	3+4	706	—	H^a	3+4, 4′	—	—	3+4
632	—	—	(3_r)	(I_r)	—	(4_r)	707	—	—	3, 3+4	—	—	3+4, 4′
633	—	—	3+4, 4′	—	—		708	—	—	4	—	—	3, 3+4, 4^t
634	—	H^w	3, 3+4	—	H^aH^b	4′, (4^t_r)	709	—	—	3	—	—	3, 3+4
635	(Th_r)	—	(2_r), 3	(I_r)	—	3+4	712	—	—	3	—	—	4
636	—	H^c	3, 3+4	—	—	3+4	713	—	—	3+4	Th	—	3, 3+4
637	—	(H^a_r)	3+4	—	—	4′	714	—	—	3	—	—	3+4
640	—	—	3	—	—	3+4, 4′	715	—	—	3	—	(H^a_r)	4′
642	(ThI_r)	—	3	(I_r)	—	3+4	717	—	H^b	3, 3+4	—	—	4
648	—	H^s	3+4	—	H^s	3+4, 4′	718	—	—	3, 3+4	—	H^b	3+4, 4′
649	—	—	4′	—	—	4	720	—	—	2^t, 3, 3+4	—	—	3+4
650	—	—	4′	—	—	4	721	—	H^a	4′	—	—	4′
652	—	—	3, 3+4	(I_r)	—	3, 3+4	724	—	—	4′	—	—	4
653	—	—	4′	—	H^a	4	725	—	—	3	—	—	3, 3+4, (4^t_r)
654	—	—	3	—	—	3, 3+4	728	—	—	3	—	—	3, 3+4, 4^t
655	—	—	3	(ThI_r)	H^b	(3_r), 3+4, (4^t_r)	729	—	H^a	3+4	—	H^a	3, 3+4, 4^t
656	—	—	4	—	—	4′	730	—	H^a	4	ThI	—	3, 4, d
657	—	—	3, 4^t	—	—	3+4, 4^t	731	—	(H^a_r)	3, (4^t_r)	—	H^a	3+4
660	—	—	3	—	—	3+4, 4′	732	—	H^b	3	ThI	H^bH^b	3, 3+4
661	—	—	3, 3+4	—	—	3, 4^t	733	—	H^a	4, (4^t_r)	—	H^a	4
662	Th	—	3, 3+4	—	—	3+4, 4′	734	ThI	—	3	—	—	3
663	—	H^s	3	—	H^a	3+4	735	—	—	3+4, 4′	—	—	4′
665	—	—	3	(I_r)	—	3+4, 4^t	736	—	—	3+4, 4′	—	—	4′
666	—	H^a	4	—	—	3+4, 4′	737	—	H^w	3, 3+4	—	H^w	4
667	—	H^s	3, 3+4	—	H^aH^b	3, 3+4	738	—	—	3+4, 4′	—	—	3, 3+4
668	—	—	3, 3+4	ThI	—	4′, 4^t	739	—	—	3	I	—	(3_r)
670	—	H^b	(3_r)	ThI	—	(3_r), 4^t	740	—	H^a	4	—	H^a	4′
672	Th	H^b	3, 3+4	ThI	H^b	3+4	742	—	H^aH^b	3, 3+4	—	H^aH^b	3+4, 4′
674	—	—	3+4, 4′	(I_r)	—	4	743	—	H^c	3, 3+4	—	H^a	4′
675	—	—	2^t, (3^t_r), 4^t	—	—	3, 3+4, 4^t	744	(ThI_r)	H^a	3	(ThI_r)	H^a	3
677	—	H^a	4′	—	—	(3_r), 3+4	745	—	—	4′	—	—	3
678	—	—	4′	(I_r)	—	4′	747	—	—	3, 3+4	—	—	3+4
680	—	—	3+4	—	—	3+4, 4′	748	—	—	3, 3+4	—	H^b	3+4
681	—	H^a	3, 4, d	—	H^a	4′, 4, d	750	—	H^aH^b	4′	—	H^aH^a	3+4, 4′
684	—	—	3+4	—	—	3+4, 4′	751	—	H^a	3	(Th_r)	H^a	3, 3+4, (4_r)
685	—	—	3+4	—	—	3+4, 4′	753	—	—	3, 3+4	—	—	3+4, 4′
686	—	—	3	—	H^a	(3_r), 3+4	758	—	—	3	—	—	3+4
691	—	H^b	3	ThI	—	3, 3+4	759	—	H^a	3+4, 4′	—	—	4
692	—	—	3+4, 4′	—	H^{carp}	3+4	760	—	—	—	—	—	$(4'_r)$

TABLE 18.

PERCENTILE INCIDENCES OF PALMAR PATTERNS IN 200 MALES AND 100 FEMALES. THE PERCENTAGES FOR RIGHT AND LEFT HANDS SEPARATELY ARE COMPUTED WITH REFERENCE TO THE TOTAL NUMBER OF PALMS (200 IN EACH OF THE THREE SERIES).

Pattern	Males Series I		Males Series II		Females Wilder, 1922		Average, both hands in both sexes
	R	L	R	L	R	L	
Thenar+interdigital I.	3.0	7.0	4.0	11.0	3.0	7.0	11.6
Hypothenar.........	22.5	17.0	18.5	16.0	19.0	17.0	36.6
Interdigital II.......	5.0	1.5	3.5	1.0	1.5	1.0	4.5
Interdigital III......	27.5	12.5	32.0	16.0	23.0	16.5	42.5
Interdigital IV (4)....	4.5	9.0	5.5	9.0	13.5	11.0	17.5
Interdigital IV (4′)...	10.5	14.0	8.5	16.5	8.0	13.5	23.6
Interdigital IV (4^t)...	7.0	9.0	3.5	8.0	4.0	7.5	13.0
$4+4'+4^t$...........	22.0	32.0	17.5	35.0	25.5	32.0	54.1

PLANTAR PATTERNS

DEFINITION

In the present study attention is confined to the four patterns in the distal area of the sole, namely, the hallucal and first, second, and third interdigital patterns. Proximal triradii (lower deltas) have not been subject to special study, although they are indicated in Table 19.

The four patterns which are treated are comparable to the interdigital patterns of the palm, being located in relation to the interdigital intervals. At the base of each of the four outermost toes there occurs characteristically a digital triradius, its proximal radiant coursing on the sole. Thus three interdigital areas are typically limited by the proximal radiants, these areas being the sites either of patterns or open fields. Study of the three interdigital areas, and of the more independent hallucal area as well, consists in the examination of their individual configurations, with record of whether the configuration is an open field or pattern, and if the latter, further record of its type.

METHOD OF FORMULATION

The procedure in formulation is fully described by Wilder and Wentworth, whom we have followed strictly. It will be evident that two approaches are open in the treatment of plantar patterns. First, the collected fomulae may be assorted in accordance with their combinations. Wilder and Wentworth provide a code by which statement of such combinations can be abbreviated, and Wilder has since used the combinations, in codified form, for racial comparisons. In a series of plantar formulae representing the pattern and open field combinations in the soles of 100 individuals (Wilder and Wentworth, pp. 181–182)

there are 54 different formulae. Of these 33 occur but once each in the series of 200 soles, 12 are represented in from 2 to 4 soles, and the remaining nine formulae occur from 5 to 37 times each. Two-thirds of the soles bear more common formulae (those which occur over five times in the collection). The second possible approach to the statistics of plantar configurations, and the one emphasized in this study, makes readily possible the inclusion of entire collections for comparison. It consists in determination of the frequencies of patterns and open fields and of the several types of patterns, separately for each of the four areas.

RESULTS

The formulations are listed in Table 19, arranged simply in the order of accession of the prints.

The data of Table 19 are first to be analyzed for the various combinations of the four configurations, following the procedure adopted by Wilder. No noteworthy variations are found after so organizing the material, comparing our males with the corresponding figures for females (Wilder, '22). As a matter of record the data on males are presented, in Table 20.

Owing to the dispersion of combinations there may be a question of whether comparison based upon them is as adequate a measure as comparison of the configurations in each of the four areas separately. Accordingly, we have assembled in Table 21 the configuration types for each of the four areas. Again there is barely a difference between the female and male collections. The single instance of any considerable variation in the two collections exists in the second interdigital area. The incidences recorded in Table 21, based upon 800 soles, correspond very closely to the figures recently reported by Montgomery ('26, Table 1) relating to a collection of 4000 soles. Montgomery's series was obtained from students at the University of Wisconsin, 1200 males and 800 females, without distinction of stocks.

SUMMARY

The dermatoglyphic features customarily emphasized in racial comparisons (palmar main lines, palmar patterns, and plantar patterns) are studied in a collection of 200 male European-Americans. By combining the incidences here determined with the results already obtained in other collections of European-Americans the racial characteristics stated in terms of incidence approach more dependable values; in view of possible sexual distinctions the addition is especially noteworthy, in that the comparable studies hitherto recorded (Wilder, '22) have dealt with females.

TABLE 19

Plantar Pattern Formulae, 100 Males. Series I

Acc No.	RIGHT	LEFT	Acc. No.	RIGHT	LEFT
1	A noo	A woo d	165	A owo d	A owo d
2	W ouu dd	W ouu dd	168	O uno	A nno
6	A ooo	A ooo	170	W nno	W nno
7	W ono	B ono	176	W ouo d	W ouo d
8	A ouu dd	A ouo d	177	A ouo d	A ooo
10	B ooo	B ouo d	180	B ouo d calc.	O nuo
11	A ouo d	A ouo	181	W nuu dd	W nuu dd
14	W ouu dd	W ouo d	187	A ooo	A ooo
15	A nuo d	A ouu dd	188	W ouo d	W ouo d
18	A noo	W noo	190	A wuo	W nuo d
38	A ooo	A ooo	200	A ouo d	A oou d
41	W ouu dd	W^{TL}ouu dd	215	A ouo d	A ouo d
44	A owo d	A nwu dd	217	B nuo d	W nuo d
45	W nwo d	W nwo d	218	W ouo d	W ouo d
46	B ouo d	B owo d	221	A ouo d	A ouo d
47	W nuo d	A ooo	222	W ooo	W ooo
50	B ouo d	B uoo d	226	B nwu dd	B nuu dd
52	A ouo d	A nuo d	229	W ouo d	W ouo d
53	W ooo	W ooo	231	W ouo d	W ouo d
54	A ouu dd	W ouu dd	246	A ouu dd	W ouu d
55	W^{sm}nwo d	W^{sm}nuo d	255	A uuo dd	A ouo d
56	W ooo	W ooo calc.	256	A ooo	A noo
57	A nuu dd	W nuu dd	260	A nuo d	A ouo d
58	A ooo	A ooo	261	A ouo d	A ouo d
62	A nuo d	A nuo d	262	B nuo d	B ouo d
67	A ouo d	A ouo d	263	A ouo d	A ouo d
69	A ouo d	A ouo d	265	A nuo d	A owo d
70	A ouu dd	A nuu dd	266	B own d	O ouo d
71	A noo	A ouo d	267	W ooo	W noo
72	B noo	W noo	269	A ouu dd	B owo d
85	A ouo d	A ouo d	270	W ouu dd	B ouo d
86	W ouo	W ooo	271	A ouo d	A nun d
88	W ouo d	A ouo d	273	A ouo d	W nuo d
98	A ouo d	A ouo d	275	B ouo d	B ouo d
108	W ooo	A ooo	276	A ouo d	A ouo d
109	A ouu dd	W ouo d	277	A ouo d	A uuo dd
110	A ooo	A ooo	285	A ouu dd	A oou d
120	A ouo d	A ouo d	287	A ooo	O ooo
129	A ooo	A ooo	288	A ouo d	W ouo d
130	A ouo d	A oou d	289	A ouo d	W nuo d
132	W ouo d	W ooo	292	A ooo	W ooo
133	A uno d	A uno dd	293	C oun	O oou
141	A ouo d	A ouo d	294	A ouo d	A ouo d
144	A unn d	A uwn dd	295	W nuo d	W nuo d
147	W ouu d	A ouo d	500	W nuo d	W ouu dd
148	B ouo d	W noo d	501	O woo	O nuo
149	A onn	W onn	502	W ouo d	W ouu dd
159	O oou	O ouu d	503	O nwo	A ouo d
160	A ooo	A ooo	504	A ouo d	A ouo d
162	A uwo dd	W ono	505	A ouo d	A ouo d

TABLE 19

Plantar Pattern Formulae, 100 Males, Series II

Acc. No.	RIGHT	LEFT	Acc. No.	RIGHT	LEFT
616	A ooo	W ooo	693	O woo	O ouo
618	A ouu dd	A nuo d	695	A ouo d	A ouo d
619	A uuo dd	A uuo dd	696	W owo d	A ouo d
620	A nuo d	B nuo d	698	A ouo d	A ooo
621	A nwo d	A nuu dd	699	W ouo ~~d~~	A ooo
622	W owo d	W onu d	700	A nuu dd	$W^{(A)}$ nou d
625	A ooo	B ooo	701	A uoo d	A nuo d
626	A owo d	A ouo d	702	B owo d	C uwo d
628	W nwu dd	B nuo d	703	A ouu dd	A ouo d
629	A ouo d	A ouo d	704	W ooo	W ooo
630	A ooo	A ooo	705	A ouo d	W ouo d
631	A nwo d	A owo d	706	B ooo	B noo
632	A uou dd	A ouo d	707	W uoo d	W ooo
633	A nuo d	A noo	708	A ouo d	B nuo d
634	W ouo d	B nwo d	709	A ouo d	A ouo d
635	A ouo d	A nuo d	712	A ouo d	A ouo d
636	A ouo d	A ouo d	713	A ooo	A ooo
637	A ooo	W ooo	714	A^{wen} ouo d	A ooo
640	A ouo d	A ouo d	715	B owo d	B owo d
642	B ouo d	B ouo d	717	W nwn d	W nwo d
648	A noo	A nno	718	A uoo d	A ooo
649	A ooo	A ooo	720	A ouu dd	A ouu dd
650	W ouo d	A ouo d	721	A ouo d	A ouo d
652	A uuo dd	A uuo dd	724	A ooo	W ouo d
653	W ooo	W ooo	725	W ouo d	W ouo d
654	A ouo d	A ouu dd	728	A nuo d	A noo
655	A owo d	A noo	729	B nuu dd	B nuo d
656	A ouu dd	A ouo d	730	A uuo dd	A uuo dd
657	O ouo	A ouo d	731	A ouo d	B nuo d
660	A oqo	A ono	732	A ooo	W ouo d
661	A ouu dd	W ouo d	733	W ooo	W ooo
662	A ouo d	A ouo d	734	W ouo d	W nuu dd
663	B ono	B ooo	735	A owo d	A owo d
665	B owo d	B ouo d	736	A ouo	A ooo
666	A quo d	A ooo	737	A oon	A ooo
667	A ouu dd	A ouo d	738	W ouo d	W ouo d
668	W nuu dd	W ouo d	739	A uoo d	A ooo
670	W wnn d	W unn d	740	A ooo	W ooo
672	B nwo d	B nno	742	A ouo d	W ouo d
674	W ooo	W ooo	743	W ono	B ono
675	B ouo	W ouo	744	W ouo d	W ouo d
677	A ouo d	A ouo d	745	W ouo d	W ouo d
678	B own d	B ouo d	747	A ouu dd	A ouo d
680	W nwo d	W nwo d	748	C ouo	A ouo d
681	A noo	A noo'	750	A ouo d	A ouo d
684	W nuo d	W nuo d	751	W nuo d	W ouo d
685	W ouo d	B nuu dd	753	A ouo d	W nuo d
686	A nwo d	A nuo d	758	W ouu dd	W ouo d
691	W nuo d	W nuo d	759	A ouo d calc.	A' ouo d calc.
692	B nuo d	A ouo d	760	W ouo d	W ouo d

TABLE 20.

The Combinations of Hallucal and Interdigital Patterns in 200 Males (400 Soles), Stated in Percentile Occurrences; Formulations and Code Following Wilder and Wentworth.

Code number	W	A	B	C	O	All hallucal types combined
1	5.75	10.25	1.0	—	0.25	17.25
2	—	0.75	—	—	0.5	1.25
3	—	0.25	—	—	—	0.25
5	10.25	22.5	3.5	0.25	0.75	37.25
6	3.0	4.25	—	—	0.25	7.5
7	—	—	—	0.25	—	0.25
9	0.75	0.25	0.75	—	—	1.75
10	0.25	—	—	—	—	0.25
11	0.25	0.25	—	—	—	0.5
13	0.5	2.25	1.5	—	—	4.25
15	—	—	0.5	—	—	0.5
17	0.25	0.75	0.25	—	—	1.25
18	—	0.25	—	—	—	0.25
21	—	2.0	—	—	—	2.0
25	—	0.5	—	—	0.25	0.75
27	0.25	0.25	—	—	—	0.5
29	—	0.25	—	0.25	—	0.5
31	—	0.25	—	—	—	0.25
33	1.0	2.75	0.25	—	—	4.0
34	0.25	—	—	—	—	0.25
37	3.75	3.5	2.0	—	0.5	9.75
38	1.25	1.0	0.75	—	—	3.0
41	0.5	0.5	0.25	—	—	1.25
45	1.5	0.75	0.5	—	0.25	3.0
46	0.25	0.25	0.25	—	—	0.75
47	0.25	—	—	—	—	0.25
49	—	0.25	—	—	0.5	0.75
53	—	0.25	—	—	—	0.25
59	0.25	—	—	—	—	0.25

TABLE 21.

The Percentile Occurrences of Particular Pattern Types and Open Fields in the Four Distal Plantar Areas. Wilder's Data ('18; '22) on Females Have Been Transcribed into the Present Form for Comparison with Males.

Area	Configuration	Incidence in 200 males	Incidence in 200 females
Hallucal	A	54.25	55.25
	B	11.5	8.25
	C	0.75	0.25
	W	30.25	32.75
	O	3.25	3.5
Interdigital I	O	71.0	74.25
	U	5.5	4.5
	∩	22.25	18.5
	W	1.25	2.75
Interdigital II	O	25.25	35.5
	U	60.0	48.75
	∩	5.25	4.5
	W	9.5	11.25
Interdigital III	O	83.75	81.5
	U	13.25	15.5
	∩	3.0	2.5
	W	—	0.5

Excepting minor differences in incidence established by the introduction of the present series, it may be stated that Wilder's generalizations concerning European-American characteristics are confirmed. Details are presented in the text and tables.

The consideration of palmar main lines is based both on the current mode of assortment and on a proposed revised treatment which is believed to obviate certain weaknesses inherent in the former. The advantage of the suggested modification is first illustrated by its application in two collections of Japanese (Hasebe, '18; Wilder, '22), with elimination of disparities associated with the prevalent method of grouping main lines. A further suggestion involving the technique of racial comparisons is concerned with plantar patterns; emphasis is here directed to patterns and open fields in the four distal areas singly, rather than to a sole individually with its combination of patterns and open fields.

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LITERATURE

THE RELATION OF NATURE TO MAN IN ABORIGINAL AMERICA. By Clark Wissler. 8°, Oxford Univ. Press, N. Y., 1926.

In a popular book intended to set forth principles for a wide audience the greatest care should be taken in regard to accuracy of fact, and the presentation of theories that are not securely founded should be avoided. The more apparent caution is expressed, the more real caution should be required.

In both these respects we should have wished for greater caution in Dr. Wissler's book, "The Relation of Man to Nature in Aboriginal America," at least in the chapter on Somatic Characteristics, the only one with which we are here concerned.

I do not quite understand why he claims novelty for his method. He says, "Nor has the distribution method been rigorously tried by anthropologists, except as to assumed racial types, such types being regarded as complexes of many variable characteristics" (page 118). Does not anthropological literature abound in maps of distribution of specific features and does Dr. Wissler not use them extensively in his own discussion? In most cases investigators have refrained from interpolating contour lines but have rather given the data for those administrative areas,—departments, counties, states,—to which they refer. Contour lines such as Struck and myself have repeatedly applied, always contain a subjective element, although they offer the advantage of a clearer view of the distribution.

Neither is his statement novel that extreme forms are always found localized, a fact that may be seen in every map. The areas of the highest elevation of land and the lowest depths of the ocean, those of heaviest rainfall and of greatest aridity, or those of greatest density of population are restricted in extent. In generalized representations these extremes are always surrounded by areas of gradual decrease or increase of the values under discussion. So it is with bodily forms. Necessarily we must either have an absolutely irregular distribution,—which means in generalized representations, no local differences at all,—or the extremes, which are always rare, will be confined to small areas. On account of the conditions of geographical distribution these will gradually merge into the more frequent middle values, which occupy large areas.

I do not understand the claim that an increase in numbers and smaller size of geographical groups would make zones more regular (page 122). The contrary is the truth as may be seen for instance in Livi's detailed maps of Italy. No biological inferences can be drawn from such distributions, and they do not show "that the bodies of the Indians form a medium in and through which are diffused one unit character after another," and that "each population may be a medium for the same kind of diffusion" (page 124).

The treatment of variability gives as facts data that are, to say the least, very doubtful. It is true enough that in a mechanical mixture of

diverse types variability is increased, not for biological reasons, but as a purely statistical phenomenon. It is quite a different question whether the variability in groups of mixed descent is always increased. Anthropologists are still investigating the question with results that show that there is no uniformity in behavior of various parts of the body. If Dr. Wissler would consult Dr. Sullivan's treatment of the Sioux measurements, which are part of the material collected by me in 1892 and which he quotes, he would find that for a measurement as different in Indian and White as the bizygomatic width, there is no appreciable increase in variability among half-bloods. For the Indians he found a variability of ± 5.45 mm., for half-bloods ± 5.49. I obtained for Indians the values ± 5.56, for half-bloods ± 5.70; Jenks for French ± 5.35, for Indians ± 3.68, for Indian half-bloods ± 5.71. Dr. Wissler's data on Italy cannot be used without serious corrections because in southern Italy where short statures prevail, all the individuals under 154cm.—and there are many of these,—have been excluded, with the result that the variability of the enlisted men in provinces of short stature is too low. I fail to see any difference in the statement attributed to me (page 130), that the high variability of head index in central Italy is presumably due to mixture of two types, and his own that "the indications point clearly to an overlapping of two adjacent distributions," and that "the centers of low variability are also the centers for round and long heads respectively" (page 131).

The correlations between frequency of Italians in American populations and stature express that a certain percentage of Italians in a given population will reduce stature so and so much, provided, of course, that there are no other strains present that may cause an increase. As actual numerical values they are hardly significant, because the distribution of Italians and of other populations is anything but normal. I do not understand why at this place Dr. Wissler assures the reader that small numbers of cases are as reliable as larger numbers and why he emphasizes rather the agreement between groups, which, of course, is worth something (page 140); while on page 151, in treating of half-breeds and full-bloods the same argument is not applied.

The interpretation of the intimate relation between variability and absolute value of stature does not seem convincing. Variability depends upon a multiplicity of causes. If it happens to be true that the variability increases more rapidly than absolute measures, this is no proof that groups having high measures must be of mixed descent. We do not know the contributing causes, and great variability of external conditions controlling stature may be a sufficient reason. The comparison of racial and social groups shows that conditions influencing a whole group may act on different measurements, such as stature and weight, at the same rate, and it may well be that the greater intensity of action, if it is permissible to use this term, gives the observed results. Dr. Wissler's consideration is quite inapplicable to an artificial value like the cephalic index. A high index is certainly not greater in an anatomical sense than a low index. If we should happen to express length of

head in per cents of width, all the values would be reversed and he would have to explain why now the variability behaves quite differently.

His discussion of increase in stature is not acceptable. He claims that the whole theory of increase of stature with change of environment is due to my measurements of immigrants in America made in 1910. The data are much older; I mention Gould's, Bowditch's and Peckham's observations which have demonstrated this difference years ago. Besides this, the statement that from the writings of investigators "one gets the impression that almost any kind of change may make people taller," is hardly borne out by the facts. This opinion has never been expressed by those working in this field. It is not due "to loose ways of thinking." Apart from his own statement in which he cites the decrease in stature in Denmark from 1913 to 1919, an example which might have been forcibly supplemented by other data from Europe collected during and following the war, he might have seen that the observations on immigrants to which he refers show a decrease in the stature of Italian immigrants. "The thoughtful reader who raises the interesting question, what would have happened to the children of immigrants if they had remained at home?" would reply to the author's skepticism by pointing out to him that those children of these families that were born abroad differ from those of the same families that were born here and that those born abroad are much nearer the home values than those born here. The fact that they are later born children of the family has no bearing on this question.

That bulk of body in size and in weight depends upon nutrition has been amply demonstrated by experiments on animals.

The statement that I have claimed mixture as the sole cause for increase of stature among half-breeds is incorrect. I have pointed out that in many tribes mixed bloods are taller than full bloods and that, on the average, they have more children for each family. The latter observation has been corroborated in a study of fuller material by R. B. Dixon. The origin of the Indian mixed population makes it quite certain that the present measurements for soldiers from western states cannot be used as a convincing argument for a comparison of mixed bloods and of their white parents. If the consideration of data in smaller groups means anything, as Dr. Wissler claims on page 140, then the half-breeds are taller than the Indians and in a number of cases at least, also taller than the white parents, judging their values by European standards.

It seems to me that in the discussion of the great differences between the averages of single Indian tribes and that of groups of European nations material is compared that is not comparable. Indian tribes correspond, if to anything in Europe, to small inbred communities from different parts of the continent. These are not so common on the densely populated continent as among the scattered communities of ancient North America, but if these samples are taken on the same basis as in America, beginning with the short Laps,—or, if these should be excluded,—with the short Sardinians, and we proceed to the Scotch and Dinarians, we find the same range that exists among the Indians. If

Swedes or Italians or the modern mixed population of the United States are to be compared with the Indians, then a limited section of the continent as, for instance, the western plains should be selected and then it would appear that conditions on the two continents are just the same. What Dr. Wissler shows is merely that he compares a population combined of many distinct groups with another one in which the groups are kept apart. If we had the data for Europe for small, inbred, village communities and these were compared, the range for Europe might easily be found to equal or exceed that of the Indians. The entire discussion is based on the trite fact that modern dense populations are thoroughly integrated. No biological conclusion of any value can be drawn from this consideration.

The discussion of the segregation of characters, page 164, seems to me also without biological significance. The distribution of stature in America depends upon many causes, among others, upon descent and mode of life. On the whole, the stature in sparsely settled, white communities is high and it is of interest to study the character of the distribution. The lines of statures over 68 inches given on page 168 do not follow from the data in the army statistics. These show rather a belt of stature below 68 inches which runs from central and southern California across to North Dakota. One area of tall stature is found northwest of this belt, the other southeast of it. It must be borne in mind that the depression in New Mexico is due to the numerous Indian population, the high values in Dakota to the tall Indian population. In the main, the distribution of stature of negroes, Indians and whites of varied descent are determining factors, not segregation dependent upon geographical conditions.

The presentation of the views of anthropologists regarding the significance of race are hardly fair to them. Dr. Wissler claims that nobody believes in independent origin of similar forms, that for instance, the short-headed people of different parts of America must all have had a common origin. We know that parallelism of forms not only in one species, but in quite different genera and families, is of frequent occurrence. The marsupials repeat the forms of the higher mammals. Parallelisms in different families are frequent in the plant world. No anthropologist having biological training, claims that short-headed races among the American Indians, Europeans, and other races, must all be of the same origin. I know of no student of physical anthropology, except Prof. Dixon, who would claim that "in the beginning of man's career there was a long-headed and a round-headed race well stabilized and breeding true," (page 174), even though similar opinions are held by some for a much later period and for sub-types.

To sum up, it would seem that the method of applying a study of distribution in the way carried through by Dr. Wissler, lacks a careful biological analysis. He would have fared better if he had applied to his own method his warning, when he says (page 178), "Anthropologists, while knowing they had a biological problem, refused to look at it in a biological way and have suffered the consequences of all who bank on self-sufficiency." It seems to me that owing to the uncritical use of geographical methods, his own considerations do not lead to valuable results.

Franz Boas

The Lumbo-Sacral Vertebral Column in Man, Its Stability of Form and Function. By Willis (Theodore A.)—*Am. J. Anat.*, XXXII, 1923, No. 1, 95–123.

"Comparison of mammalian vertebral columns shows evidence of an evolutionary shortening of the column in the Primates.

The human column, however, has a relatively high degree (95.8 per cent) of stability with a modal thoracico lumbar number of 17.

The lumbar portion of the column adjacent to the sacrum presents certain morphological defects described as bifid and separate neural arches, the latter occurring three times as frequently as the former. Both defects result in weakness of the column; the bifid arch by impairing ligamentous attachments; the separate arch through loss of bony anchorage until put to test by severe stress or trauma.

The bifid arch is due to arrest of development before fusion of the laminae takes place; the separate arch to irregular ossification with interruption of bony continuity.

Muscular strains, lumbo-sacral sprains and spondylolisthesis often accompany these developmental defects, but may also be dependent upon malformations of the articular processes."

Numerical Significance in the Thoracico Lumbar Vertebrae of the Mammalia. By Todd (T. Wingate)—*Anat. Record*, 1922, XXIV, No. 5, 261–286.

"The following accepted ideas regarding the presacral vertebral column in mammals are undoubtedly correct. The primitive mammalian number of thoracicolumbar vertebrae is and always has been nineteen. In most orders of mammals there is a tendency to increase this number (Welcker's auxispondylous group). In Primates the tendency is to reduce the number, the anthropoids and Man forming Welcker's lipospondylous group. So far as the thoracicolumbar column is concerned Man takes his place between the gibbons and the giant black anthropoids.

The lemurs form the connecting link between the Primates and other mammalian orders. Whereas some in their specialization exhibit an increase in number like the auxispondylous mammals, there are others which lean towards the typically higher Primates in their tendency towards reduction in number of thoracicolumbar vertebrae. The relation of vertebral formula to specialization in the lemurs is quite significant.

The New-World monkeys show a greater tendency towards reduction in number, but here also there is marked bias towards increase in number, as in many lemurs.

The primitive number nineteen is characteristic of both subfamilies of Old-World apes, only rare examples showing an increase to twenty.

The anthropoids and Man exhibit progressive reduction in number, but of all this group Man presents by far the most stable condition numerically in his vertebral formula. The precise stability for Man is strikingly given in the recent works by Willis."

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